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THESIS

A THEORY AND MODEL FOR THE PLANNING OF LAND COMBAT

by

Thomas Joseph Schwartz

September, 1990

Thesis Co-Advisors:	William J. Caldwell Laura D. Johnson

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Planning land combat operations requires a method of evaluation to determine the strengths and weaknesses of the various possible courses of action. The principal means of evaluating these courses of action is wargaming. Some research indicates that planning efforts lack a coherent set of wargaming rules and principles that are widely accepted and understood by military professionals. This thesis develops a theory of combat for use by military professionals in the planning of land combat. The theory provides a method for evaluating alternative courses of action at the brigade through corps level that can be easily applied. The theory is based on the analysis and modeling of categorical data from the U.S. Army Concepts Analysis Agency's Benchmark database. The database includes 260 combined arms battles from the period 1937 through 1982. Loglinear models provide maximum likelihood estimates of the probability of an attack's success. The principle of falsification is explained and used to validate the theory using the historical data. Applications of the theory and model to the planning of land combat are discussed and areas for further research are outlined.

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A Theory and Model for the Planning of Land Combat

by

Thomas Joseph Schwartz
Captain, United States Army
B.S., United States Military Academy, 1981

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

NAVAL POSTGRADUATE SCHOOL
September 1990

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ABSTRACT

Planning land combat operations requires a method of evaluation to determine the strengths and weaknesses of the various possible courses of action. The principal means of evaluating these courses of action is wargaming. Some research indicates that planning efforts lack a coherent set of wargaming rules and principles that are widely accepted and understood by military professionals. This thesis develops a theory of combat for use by military professionals in the planning of land combat. The theory provides a method for evaluating alternative courses of action at the brigade through corps level that can be easily applied. The theory is based on the analysis and modeling of categorical data from the U.S. Army Concepts Analysis Agency's Benchmark database. The database includes 260 combined arms battles from the period 1937 through 1982. Loglinear models provide maximum likelihood estimates of the probability of an attack's success. The principle of falsification is explained and used to validate the theory using the historical data. Applications of the theory and model to the planning of land combat are discussed and areas for further research are outlined.

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I. INTRODUCTION

A. THE COMMAND ESTIMATE

The process of making an estimate, or estimating the situation, has always been an integral part of military planning. Sun Tzu, a Chinese general wrote about 500 B.C. in *The Art of War* :

> Now if estimates made in the temple before hostilities indicate victory it is because calculations show one's strength to be superior to that of his enemy; if they indicate defeat, it is because calculations show that one is inferior. With many calculations, one can win; with few one cannot. How much less chance of victory has one who makes none at all! By this means I examine the situation and the outcome will be clearly apparent. [Ref. 1: p.71]

The recommended command estimate process for the development of estimates in the United States Army is stated in *Field Manual 101-5, Staff Organization and Operations*, and Command and General Staff College *Student Text 100-9, The Command Estimate*. The command estimate process is outlined in Figure 1 on page 2. Alternative courses of action are formulated during this process. These alternative courses of action must be compared with each other using criteria set by the commander to determine which will be adopted. These criteria may include, for example, minimizing friendly casualties and equipment losses, adherence to certain doctrinal concepts (e.g. principles of war, Airland Battle doctrine), or the development of an acceptable force ratio. The focus of this thesis is to compare these courses of action based on a quantitative evaluation of the relative probability of success of each one as estimated from the historical data.

Research in the course of action analysis process is ongoing at the Army Research Institute (ARI) Fort Leavenworth Field Unit. The following statements characterize the preliminary results. First, the process as outlined in *ST 100-9* is not being used in observed staff planning situations [Ref. 2: p. 1]. *ST 100-9, The Command Estimate*, is the instructional text used to instruct future general staff officers in the application of the command estimate process, and is also intended for use as a reference by units in the field. In a number of observed battalion and division level command post exercises only one course of action was generated and all efforts were focused on the development of the plan for that course of action. Notable weaknesses discussed in the published report included the comparison of the alternative courses of action, and in particular, that there is no recommended means of predicting battle outcomes [Ref. 3: p. 8]. The few tables

RECEIVE THE MISSION
LIST FACTS AND ASSUMPTIONS
ANALYZE THE MISSION
RECEIVE THE COMMANDER'S GUIDANCE
DEVELOP COURSES OF ACTION
ANALYZE COURSES OF ACTION
RECOMMENDATION/DECISION
ACTIONS AND ORDERS
SUPERVISION

Figure 1. The Command Estimate Process

that are provided in *ST 100-9* enable the user to compute a force ratio but give no estimate of the chance of a successful battle outcome. The same observation is made by the Center for Army Tactics, the author of *ST 100-9*, in a memorandum addressing priorities for the development of automated staff planning aids [Ref. 4: pp. 24 and 37].

A possible reason for staffs not using the command estimate process and in particular, the wargaming of alternative courses of action, is a lack of understanding and confidence in the model itself. There are currently hundreds of combat models and computer simulations that attempt to replicate combat, and we are spending millions annually to develop improved versions of these and new models. J.A. Stockfisch suggests in a 1975 RAND report that a reason for the proliferation of combat models is the degree of immaturity of the study of combat. Immaturity in this context refers to the poor development of the correspondence between theory and reality [Ref. 5: p. 6]. Stockfisch notes that physics is an example of a discipline in which the correspondence between theory and reality is highly developed. Another analogy is particularly applicable to the analysis of alternative courses of action. A doctor of medicine presumably would not use a laboratory test to diagnose a patient's condition if he did not at least know the reliability of the test. Similarly, a military professional should not use a method to evaluate alternative courses of action if he does not have confidence in it. Professional military education in the United States Army does not address a theory of combat or combat processes other than the reading of military history for qualitative lessons and insights.

B. HIERARCHY OF COMBAT AND SCOPE OF THIS THESIS

Before defining the scope of this thesis it is necessary to define combat and the levels of combat that will be addressed. Military combat is the employment of weapons by organized forces with hostile intent for the purpose of protecting, controlling, or seizing territory, people or resources [Ref. 6: p. 64]. This definition will be used wherever combat is discussed.

Within the overall concept of combat there exists a hierarchy of levels of combat. These levels of combat are illustrated in Figure 2 on page 4 and are adapted from Dupuy's *Understanding War--History and Theory of Combat.* Three of these levels of combat are applicable to the theory and model of combat that will be developed here and are further defined [Ref. 6: p. 65] below.

- **Campaign:** A campaign is a series of military operations coordinated in time and space and directed toward a specified strategic objective. Campaigns are usually composed of several battles and may last several weeks to a year.
- **Battle:** A battle is combat between major forces with an operational mission and may last several days to a few weeks.
- **Engagement:** An engagement is combat between forces of company through division strength and is often part of a larger battle. Engagements may last several hours to a few days.

The data that will be used to develop the theory and validate the model consists of campaigns, battles and engagements from the period 1937 to 1982.

There is a division of military theory that will further narrow the scope of this thesis. Military theory, as seen in Figure 3 on page 5 is divided into the philosophy of war and the theory of combat. The philosophy of war deals with the political, economic and social context of warfare and the aims of war detailed by the nation's political leadership. The theory of combat utilizes the expertise of the professional soldier and frames the study of military organizations, operational concepts, and military endeavors. Military strategy, jointly formulated by the political and military leadership, is common to the

LEVEL OF COMBAT	UNITS INVOLVED
WAR	NATIONAL FORCES
CAMPAIGN	FIELD ARMY/ARMY GROUP
BATTLE	ARMY GROUP/ARMY CORPS
ENGAGEMENT	DIVISIONS-COMPANIES
ACTION	BATTALIONS-SQUADS
DUEL	TWO SYSTEMS/INDIVIDUALS

Figure 2. Hierarchy of Combat

philosophy of war and the theory of combat, serving as a bridge between the two [Ref. 6: p. 65].

With regard to military expertise and professionalism the following point will be a recurring theme throughout this thesis. Stockfisch in *Models, Data and War: A Critique of the Study of Conventional Forces*, stated:

> There also exists a body of knowledge relevant to military operations, which is possessed by the Officer Corps and is the product of both experience and intensive study. This body of knowledge is often referred to as military judgment. That expression is unfortunate whenever the context suggests that the kind of information it incorporates is either inferior or superior to knowledge that is produced by application of scientific quantitative methodology. Particularly misleading is the idea that knowledge produced by the application of quantitative methodology is objective, whereas military judgment is subjective. Assertions or beliefs along these lines may not even be meaningful hypotheses that can be tested or resolved in any satisfactory way. [Ref. 5: p. 6]

This statement further refines the requirement that the theory and model to be developed be understood by the user, the military professional. Not only must the inputs and

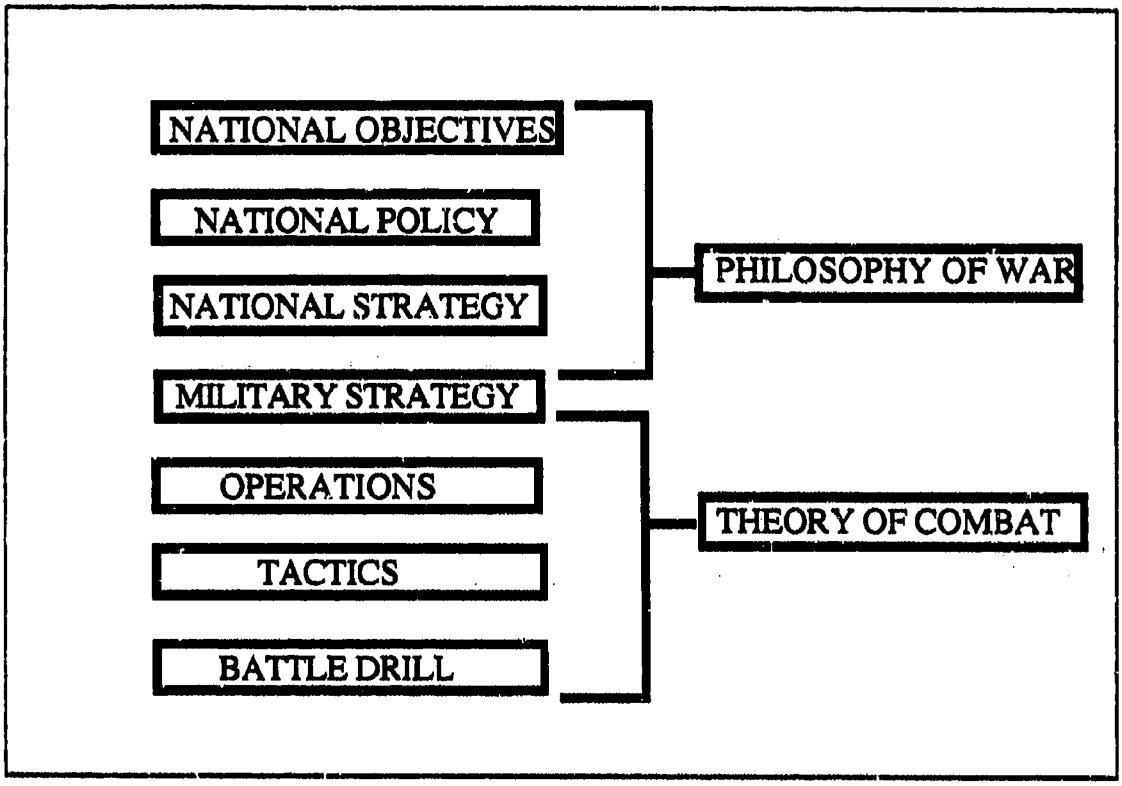

Figure 3. Spectrum of Military Theory

outputs of the model be understandable, but also the relationships must not run counter to military judgment.

C. THESIS GOAL AND OUTLINE

The goal of this thesis is to develop a theory for use by military professionals in evaluating alternative courses of action for land combat operations by units at the brigade through corps levels. The theory is intended to be understood by the user, credible by means of historical validation, and easily applied to the planning of land combat operations without need for computational support.

Chapter I has addressed the framework of military planning and the hierarchy of combat. In Chapter II the concept of a theory of combat will be introduced and a theory intended for planning purposes will be detailed. Chapter III will define the assumptions, database and methodology used to analyze the historical data. Validation of the theory from the results of the data analysis will be discussed in Chapter IV.

Chapter V will propose applications of the theory to the planning of land combat operations. The final chapter, Chapter VI, contains concluding remarks and recommendations for further study.

II. A THEORY FOR PLANNING LAND COMBAT

A. DEVELOPMENT OF A THEORY OF COMBAT

Two sources that establish a need for the development of a theory of combat are Huber, Low, and Taylor in *Some Thoughts on Developing a Theory of Combat* (1979) [Ref.7], and T.N. Dupuy's *Understanding War-History and Theory of Combat* (1987) [Ref.6]. Dupuy defines a theory of combat as *an organization of fundamental laws about combat that explain the interaction of combat forces and processes* [Ref.6: p.79]. Huber, et.al. has the same definition and further defines a law of combat as a "confirmed hypothesis" about combat [Ref.7: p.4,30]. The combat processes that are the subject of the theory of combat and the hypothesized laws of combat may include:

- **Attrition:** the infliction of casualties on an opposing force
- **Manuever:** the movement of forces to gain advantage
- **C3I:** command, control, communications, and intelligence functions of commanders and their staffs
- **Support:** the logistical support of forces in the field

The approaches to developing a theory of combat, that is developing the hypotheses about combat are three:

- **Historical:** based on the analysis of historical data from combat
- **Judgmental:** based on field experiments, exercises and military judgment
- **Operational analysis:** based on physical or formal models

These three approaches are complementary, and an adequate theory may combine these approaches [Ref.7: pp.8-9]. The theory developed here combines these approaches by analyzing historical data and comparing the results with military judgment.

B. A THEORY FOR PLANNING LAND COMBAT

The following statements are the hypotheses about combat that will compose the theory for the planning of land combat in this thesis. These hypotheses will then be tested using the statistical methodology discussed in the next chapter.

1. Superior Combat Power Wins

The statement that superior combat power wins on the battlefield may be an obvious one, but the measurement of combat power is a subject of considerable discussion. The Army's principal doctrinal manual, *FM 100-5, Operations* , has this to say about combat power:

> The dynamics of combat power decide the outcome of campaigns, major operations, battles and engagements. Combat power is the ability to fight. It measures the effect created by combining manuever, firepower, protection and leadership in combat actions against an enemy in war. [Ref.8: p.11]

It is traditionally thought that a three to one superiority in combat power, measured by some kind of force ratio, is required for an attack to succeed [Ref.9]. This thesis attempts to develop a statistically significant measure of combat power for use in the planning of operations. The measures of combat power that will be considered include the ratios of attacking to defending troops, attacking to defending artillery pieces and attacking to defending tanks, and combinations of these three.

2. The Law of Diminishing Returns/Economy of Force

While superior combat power may win battles, at some level of combat power the "marginal value of an increment of combat power is less than the marginal value of the incremental results achieved." [Ref.7: p.125] The hypothesis to be tested is that as combat power is increased at a constant rate, the likelihood of an attack's success will increase more rapidly than combat power to a certain point, after which the rate of increase will be less than the rate at which combat power is increased. This effect, if present, would support the military principle of economy of force, which is "Allocate minimum essential combat power to secondary efforts." [Ref.8: p.175]

3. Combat Multipliers: Terrain, Posture and Surprise

A combat multiplier is a factor that increases the combat power of one side relative to the other. This theory hypothesizes that the terrain on which the battle is fought, the posture of the defending force, and whether or not the attacking force achieves surprise are combat multipliers.

The defender has an advantage in that he usually chooses the terrain on which the battle will be fought.

> Terrain forms the natural structure of the battlefield. Commanders must recognize its limitations and possibilities and use it to protect friendly operations and to put the enemy at a disadvantage. [Ref.8: p.76]

Terrain is categorized as flat, rolling or rugged in these data.

The defender's posture refers to the amount of preparation that he makes of his position and the level of resistance that he offers the attacker.

> The defender arrives in the battle area before the attacker. He must take advantage of his early occupation of the area by making the most thorough preparations for combat as time allows. [Ref.8: p.132]

Classifications of the defender's posture will be discussed with the database in Chapter III.

Surprise is a characteristic of combat that is difficult to achieve for either side but may have decisive results.

> Surprise is important at the operational and tactical levels for it can decisively affect the outcome of battles. With surprise, success out of proportion to the effort expended may be obtained. Surprise results from going against an enemy at a time and/or place or in a manner for which he is unprepared. It is not essential that the enemy be taken unaware, but only that he become aware too late to react effectively. Factors contributing to surprise include speed and alacrity, employment of unexpected factors, effective intelligence, deception operations of all kinds, variations of tactics and methods of operation, and operations security. [Ref.8: p.176]

The hypotheses that surprise, posture and terrain affect battle outcomes will be tested.

C. SUMMARY

We have defined a theory of combat as an organization of fundamental laws about combat that explain the interaction of combat forces and processes. These laws, or confirmed hypotheses, may be developed using analysis of historical data, experiments, exercises and military judgment, and physical or formal models. Three hypotheses have been proposed for inclusion into a theory of combat. They are, first, that superior combat power wins on the battlefield; second, that the law of diminishing returns applies to combat power; and finally, that terrain, defender posture, and surprise have a multiplicative effect on combat power. These hypotheses will be examined using the methodology discussed in Chapter III.

III. METHODOLOGY

A. THE BENCHMARK DATABASE

The data used for this thesis were assembled for the U.S. Army Concepts Analysis Agency and is contained in its research paper *Historical Characteristics of Combat for Wargames (Benchmarks)*, written by Robert McQuie [Ref. 10]. These data, from now on referred to as the Benchmark database, contain information on 260 combined arms battles from the period 1937 through 1982. Forty-five characteristics or data elements are listed in the database for each battle. The locations, time periods and numbers of battles in the database are listed in Table 1 on page 11. It should be noted, however, that approximately one-fifth of the data elements in the database are empty. This is due to the loss of records in war, inaccuracies and contradictions in historical records. Fortunately, the missing data elements are scattered about the data in a fairly random manner. The observations were censored if they contained a missing value for a variable that was to be analyzed. Even with this censoring, the smallest number of battles that were used in an analysis was 243. This means that the maximum number of censored observations was 17, less than seven percent of the total. The reliability of the available data has been checked, as noted in McQuie's report, with the most reliable data being that from battles in Western Europe and Italy, and the least reliable being that from the Korean War. The reliability of the remaining data falls between these two. [Ref.10: pp.4-8] An extract of the data from this database is given in Appendix B, and includes all of the data values and characteristics used in this report.

Table 1. LOCATION OF BATTLES-BENCHMARK DATABASE

Location	Number of battles
West Europe (1940)	5
East Asia (1938-45)	6
East Europe (1939-42)	4
North Africa (1943)	8
Italy (1943-44)	64
East Europe (1943-45)	28
West Europe (1944)	25
West Pacific (1944-45)	32
Korea (1950)	11
Israel (1948)	9
Israel (1956)	4
Israel (1967)	22
Israel (1973)	33
Other locations	9

The Benchmark database is particularly suited to the development of a theory of combat for planning purposes. While discussing the available data about combat and its uses, Taylor stated "the available real combat data does not support verification of detailed combat models, but it only supports such investigations of relatively simple aggregated large-units models." [Ref.7: p.34] This purpose is consistent with the models that are developed as a result of this research.

A number of military terms are used to characterize the battle conditions in the Benchmark database. The most frequently used terms are given below to facilitate understanding of the theory and model. The definitions are taken from the glossary of the Benchmark report to insure consistency in the interpretation of the data and models [Ref.10: p.B-1].

- **Success.** The resolution of the combat in favor of one side or the other, considering how well each force accomplished its' mission. In some battles, neither force or both forces have been successful.
- **Surprise.** Surprise occurs when one force is able to confront its opponent with tactical circumstances that the opponent did not anticipate or adequately prepare

for. Surprise may be achieved with respect to time, location, manuever or firepower.

- **Terrain.** The total topography of the battlefield as described in the sources; categorized as rough, rolling or flat.

The defender's **posture** has five different categorizations that are defined as follows:

- **Delay.** A retrograde movement in which the defender slows down and damages an advancing enemy to gain time, but does not beome decisively engaged in combat or allow himself to be outflanked.
- **Fortified defense.** A coordinated defense system prepared with sufficient time and material to complete planned entrenchments, field fortifications, and obstacles.
- **Hasty defense.** A defense normally organized while in contact with the enemy or when contact is imminent and time for battle preparation is limited. It involves the use of foxholes, emplacements and obstacles. With enough time, usually taken to be one day, a hasty defensive position can be improved to a prepared or fortified defense.
- **Prepared defense.** A defense prepared with time, often considered to be one day, to improve the position, but which due to lack of time and material has less than the strength of a fortified postion.
- **Withdrawl.** A movement in accordance with the will of a force's commander away from the enemy that terminates combat or contact with the enemy force.

Force ratios are traditional measures of combat power. These ratios are often used to estimate "how much is enough" in the preparation of courses of action and in making tactical decisions. The three most commonly used force ratios are attacking to defending troops, attacking to defending artillery pieces, and attacking to defending tanks. **Firepower indices** are sometimes used as measures of combat power. Each weapon system is assigned a firepower score, a value relative to the other weapons systems considered. For example, a soldier may be equal to a score of one, an artillery piece equivalent to a score of 65, and a tank may be 100. These scores are multiplied by the number of their respective systems on a side and summed to give a firepower index for that side. The attacking to defending indices are then formed into a ratio to evaluate the relative strength of each side.

B. DATA PREPARATION

To simplify the modeling of the response variable, success, any battle that was classified as a draw or victory for both sides was recoded as a defender success. Because there were relatively few battles that were categorized as draws or decisions for both sides, this simplification had very little effect on the overall analysis.

The majority of the data contained in the Benchmark database is categorical in nature, meaning that the data type consists of ordered or unordered classifications of the data. For instance, temperature on the battlefield is classified as hot, mild or cold (an ordered classification); defender posture is classified as hasty defense, prepared defense, fortified defense, delay or withdrawl (an unordered classification). In addition to the categorical data, numeric data is given for each side regarding the numbers of troops and weapons systems employed as well as casualties and equipment losses as a result of the battle. These numeric data were computed and then recoded into a categorical classification that could be analyzed in a contingency table and used in loglinear modeling. The classifications for all ratio scale data are listed in Table 2.

Table 2. CATEGORIES FOR RATIO SCALE DATA

Value	Code
0.0-0.5	L
0.5-1.0	M
1.0-1.5	N
1.5-2.0	O
2.0-2.5	P
2.5-3.0	Q
3.0-3.5	R
3.5-4.0	S
4.0-4.5	T
4.5-above	U

At this point it is appropriate to discuss why the force ratios were categorized in this manner when procedures for logistic regression exist. One alternative approach would be to use logistic regression with ordinal categorized variables recoded to a number code. Unordered categorical data, such as defender posture, would be recoded using several dummy variables. This was attempted using the same procedures described below for categorical modeling, but the likelihood ratio statistic used to assess model goodness of fit showed a very poor model fit to the data This may be because the variables are not linear in the logit function. Rather than finding a non-linear relationship, the ratios were categorized in a sensible manner to develop an easily understood model. The recoding of the ratios into categories and the use of all categorical data in the model produced satisfactory results.

The assumption was made that the method of categorization of numeric variables did not significantly affect the modeling result. This assumption was tested by the use of several scalings. Scalings that were more coarse did not produce statistically significant models, and finer scalings produced significant models but reduced cell size to the point where the models became unusable. The current scaling balances these considerations.

C. CATEGORICAL MODELING

Loglinear models of the categorical data were used to analyze the data. These models attempt to describe the interaction between or among variables in multidimensional contingency tables based on cross-product ratios of expected cell values. The contingency table describes the structural relationship among the variables that compose the dimensions of the table. If N is the total number of battles in the contingency table, x_{i+} is the total number of observations in the ith row, and x_{+j} is the total number in the jth column, then under the assumption of independence between the row and column categories, $\hat{m}_{ij}$, the maximum likelihood estimator of expected value of the ij cell, is

$$\hat{m}_{ij} = \frac{x_{i+} x_{+j}}{N} .$$

Taking the logarithms of both sides,

$$\log \hat{m}_{ij} = \log x_{i+} + \log x_{+j} - \log N.$$

Thus $\log \hat{m}_{ij}$ is linear in the log of the marginal totals. Under independence, $\log m_{ij}$ is modeled as

$$\log m_{ij} = \mu + \alpha_i + \beta_j$$

where

μ = *overall mean effect*
α_i = *mean effect for variable i*
β_j = *mean effect for variable j.*

In the fully saturated loglinear model

$$\log m_{ij} = \mu + \alpha_i + \beta_j + \alpha\beta_{ij}$$

where $\alpha\beta_{ij}$ is the interaction term. For the models used in this research, the response variable was always success, defined as whether or not the attack succeeded.

$$Let\ y_i = \begin{cases} 1 \text{ if the ith attack was a success} \\ 0 \text{ if the ith attack was not a success} \end{cases} \qquad i = 1,\ldots,N$$

The explanatory variables included the categorized ratio of attacking to defending tanks, troops, and artillery (each with ten levels), the defender's posture (five levels), the terrain (three levels), and whether or not the attacker gained surprise (two levels). Because there are thirty thousand cells in the fully saturated model and only 260 battles, the approach used was to search for significant subset models. Suppose we were to model success as a response to defender posture and surprise. Posture represents the rows and surprise represents the columns of the model's associated contingency table. The expected value for the number of successes in the *ith* row and *jth* column without interaction between posture and surprise can be denoted m_{ij}, where

$$\log m_{ij} = \mu + \alpha_i + \beta_j$$

where

μ = *overall mean effect*
α_i = *mean effect for posture i*
β_j = *mean effect for surprise j.*

The CATMOD procedure of the SAS statistical analysis package was used as the tool for the categorical data modeling. This procedure uses maximum likelihood to estimate parameters for loglinear models [Ref.11: p.174]. The parameters μ, α_{ii}, and β_j are estimated using an iterative method to maximize the likelihood function. The emphasis of the procedure is on model building, goodness of fit testing, and the estimation of cell frequencies and probabilities of the underlying contingency tables. The procedure's output includes profiles of the data, actual and predicted cell probabilities, analysis of parameters and effects, and the likelihood ratio statistic for assessing goodness of fit.

The following table illustrates an application of the test statistics output by the CATMOD procedure to the modeling results. One model hypothesized that defender posture and surprise could predict attack success. As seen in Table 3 on page 16 the p-value for the explanatory variable posture, which tests to see if the explanatory variable posture has an effect on success in the presence of the explanatory variable surprise, is 0.03. Thus, at a reasonable level of significance (less than 0.03), the null hypothesis that posture has no effect would be rejected.

Table 3. MODEL RESULT FOR LOGLINEAR MODEL SUCCESS = POSTURE SURPRISE

Response variable	Explanatory variables	P value of explanatory variables	P value of likelihood statistic
Attack success	Defender posture	0.03	0.95
	Surprise	0.60	

On the other hand, surprise has a 0.60 p-value, so that it is unlikely in the presence of the explanatory variable posture that surprise is a significant factor for predicting success. The p-value for the likelihood ratio statistic for the model is 0.95, meaning that the similarity between the observed battle outcomes and those predicted by the model is very high. Overall, this is not a bad model but there may be other combinations of explanatory variables with posture that may produce good models of battle outcomes. The results of this type of modeling will be discussed in the next chapter.

D. PLOTTING AND ANALYSIS OF OUTPUT

Predicted cell probabilities using the maximum likelihood estimates were input into GRAFSTAT, a statistics and graphics package on the IBM mainframe system. These cell probabilities were plotted for models that were found to be statistically significant using the tests previously discussed. The cell probabilities are an estimate of the probability of an attack's success given the conditions that define that cell in the model. The plots of the cell probabilities were smoothed using LOWESS, a locally weighted regression scatter plot smoothing method which employs weighted least squares to fit a line to a set of points on a scatter plot [Ref.12: p.94]. An example plot is given as Figure 4 on page 17, where the traditional force ratios and the maximum likelihood estimates of the attack probability of success are plotted. This plot is based on all of the observations in the Benchmark database. These plots were then compared with the hypotheses in the theory of combat, with historical data, and military judgment to determine lessons and insights which may be helpful for the planning of land combat.

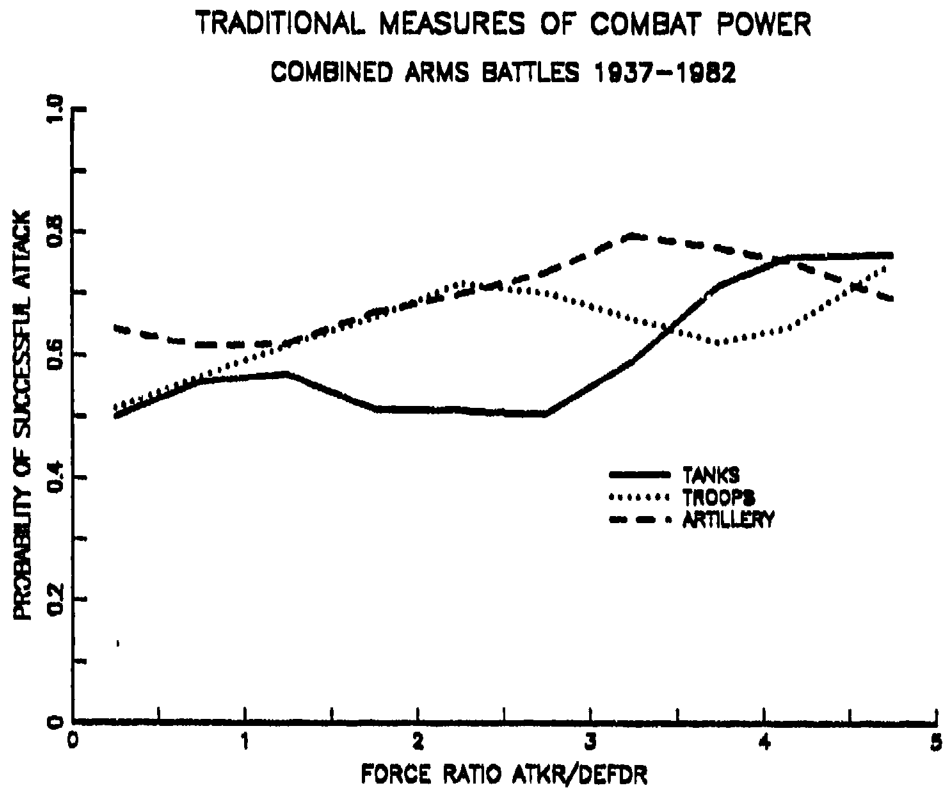

Figure 4. Traditional Measures of Combat Power

E. SUMMARY

In this chapter the methodology for the development of hypotheses about combat based on historical data and military judgment was discussed. The Benchmark data base was introduced as well as the modeling assumptions used. The analysis of categorical data with the use of loglinear models and appropriate test statistics was also discussed. In the next chapter the validation of the theory and results of the analysis will be discussed in detail.

IV. VALIDATION AND ANALYSIS OF THE THEORY AND MODELS

A. THE PRINCIPLE OF FALSIFICATION

In the previous chapter the methodology and data used to model battle outcomes were discussed. This chapter begins with a discussion of a principle for model validation, and then describes in detail the research conducted and results observed. Validation in this context means the determination of whether or not the results output by a model are a faithful representation of the actual system being modeled.

An approach to validation is to validate the underlying theory on which the model is based. In the case of this research, the theory to be validated consists of a set of hypotheses about combat and combat processes. The method of falsification as developed by Huber states that a deductively derived hypothesis about combat may be considered usable as long as historical research does not provide statistically significant evidence for its rejection. These "negative falsifications" of combat hypotheses, while not the rigorously controlled experiments of the physical sciences, may nevertheless be considered to approach validation and allow the incorporation of the hypotheses into the theory [Ref.7: p.25].

Since all of the hypotheses about combat will be tested for statistical significance using the actual data about combat, those that are statistically significant will be considered validated for the purposes of this theory of combat. These hypotheses will also need to be in agreement with military judgment so that the theory and modeling results are transparent to the intended user, the military planner.

B. OVERVIEW OF MODELS USED AND RESULTS

The number of models tried in the modeling effort was large. The following table displays some of the models developed and the wide range of significance levels observed. The statistical significance level given, α, is the maximum of the individual p-values for the model's explanatory variables. The models are arranged roughly in order of relatively best fit to worst.

Table 4. SUMMARY OF MODELING RESULTS

Response Variable: Attack Success		
Explanatory Variables	**P value of likelihood statistic**	**Overall α level**
Attacker, Posture, Surprise	0.89	0.04
Tank ratio, Posture, Surprise	0.62	0.14
Tank ratio, Posture	0.50	0.15
Tank ratio, Surprise	0.47	0.25
Attacker, Posture	0.40	0.06
Artillery ratio, Posture	0.35	0.83
Attacker, Defender	0.30	0.01
Tank ratio, Terrain	0.14	0.42
Troop ratio, Posture	0.09	0.87
Tank, Artillery, and Troop ratios	0.001	0.86

Again, the higher the p-value for the likelihood statistic, the more consistent the model is with the data. While the α level for most models is relatively high, it must be remembered that the data being modeled does not come from a rigorously controlled experiment, but from actual battles distributed over a period of forty-five years. Because combat is as much a social phenomenon as a physical one, there are many uncontrolled factors such as leadership, morale, training and doctrine. An effort was made to see if the differences in fighting capabilities between different national forces could be quantified. This effort was unsuccessful in finding a measure of the fighting capabilities of differing national forces, but the models that include the attacking and or defending forces are highly significant, probably due to the fact that the identification of the national forces captures some of the uncontrolled factors. The tabled probabilities of success by national force and posture in Appendix A may provide some insights into the fighting capabilities of the forces of specific nations.

A considerable amount of time was spent attempting to use firepower indices to quantify combat power and predict battle outcomes using categorical modeling. While highly significant scalings of firepower scores were developed, these scalings produced unsatisfactory results when combined with other explanatory variables (defender posture, surprise) to model battle outcomes. It is suggested that the subjective scaling used in firepower score methods does not capture the synergistic effects of combined arms forces. Additionally, it is not clear whether or not the relative firepower score of a system would remain constant during the time period of the data, 1937 through 1982.

A modified version of the Quantified Judgment Model suggested by Dupuy in his analysis of the 1982 Bekka Valley campaign [Ref.7: pp.237-250] was tried on the data set. This approach used essentially a firepower score approach with multiplicative factors for terrain, posture and surprise included in the firepower index of each side. This model did not produce statistically significant results in the modeling of battle outcomes.

C. RESULTS SPECIFIC TO THE THEORY OF COMBAT

1. Superior Combat Power Wins

One of the principal findings of the modeling was that the force ratios of attacking to defending troops and attacking to defending artillery pieces were not statistically significant in predicting battle outcomes. The more interesting result, however, was that the ratio of attacking to defending tanks was significant at the 0.05 level in predicting successful attacks. This may not be surprising considering that:

> In mounted warfare, the tank is the primary offensive weapon. Its firepower, protection from enemy fire, and speed create the shock effect necessary to disrupt the enemy's operations and to defeat him. [Ref.8: p.42]

This is not to say, however, that tanks are the only weapons required to conduct a successful attack. The principle of combined arms, that is an appropriate mix of infantry, armor, and artillery, supported by engineers, aviation and air defense is necessary for success. The tank ratio, however, seems to be the barometer of whether or not an appropriately balanced force has enough combat power to successfully conduct an attack. As seen in Figure 4 on page 17 the probability of a successful attack increases by fifty percent as the tank ratio increases from less than 1:1 to 5:1. An effect attributed to several Arab-Israeli war campaigns and further discussed in the analysis of posture as a combat multiplier may explain why the slight peak exists in the area of the 1:1 tank ratio. As a result of these findings, the measure of combat power to be used in subsequent models will be the ratio of attacking to defending tanks.

An attempt was made to distinguish a historical trend in the tank ratio's ability to predict battle outcomes. The data points were divided into four periods of approximately equal numbers, including 1937 through 1943, 1944 Europe, 1944 through 1953 Asia and the Pacific, and 1954 through 1982. No trends in the tank ratio's ability to predict battle outcomes were evident between the four periods, as none of the models produced significant results when tested against a subset of the data.

2. The Law of Diminishing Returns/Economy of Force

The law of diminishing returns would imply that marginal increases in combat power would have a diminishing effect on the marginal increase in probability of success as the tank ratio increases. This effect can be seen in the plot of the tank ratio in Figure 4 on page 17 as well as all of the figures in this chapter. The slope of the probability curve begins to decrease at about the 3:1 tank ratio, implying that the point where marginal cost equals marginal returns is in the vicinity of that point. While the effect of the law of diminishing returns is not statistically proven by itself, the effects are evident in the plots of statistically significant models. The land area over which forces are concentrated may influence this effect, and further research on this hypothesis is suggested in Chapter VI.

3. Combat Multiplier: Terrain

The modeling of terrain by itself and combined with other factors did not have a statistically significant effect on battle outcomes. The model results are shown in Table 5 and plotted in Figure 5 on page 23.

Table 5. MODEL RESULT FOR LOGLINEAR MODEL SUCCESS = TANK RATIO TERRAIN

Response variable	Explanatory variables	P value of explanatory variables	P value of likelihood statistic
Attack success	Tank ratio	0.08	0.14
	Terrain	0.42	

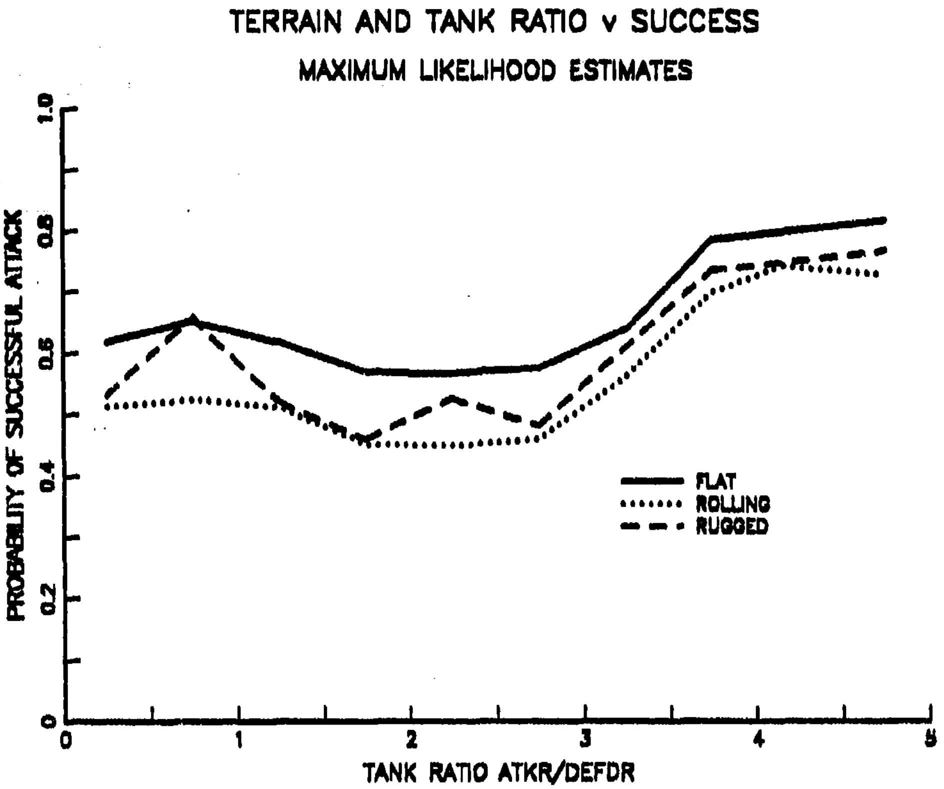

Figure 5. Terrain and Tank Ratio versus Success

The plot does show, however, that there is some effect due to terrain. While terrain is certainly significant from the perspective of military judgment, there may be a reason for its lack of statistical significance in a model. The models are based on data from battles that actually occurred. In most of these instances the attacker probably had the option not to attack if he felt that the terrain was to his disadvantage and he did not have other means of gaining an advantage. It is interesting to note that the combination of terrain and posture did not produce a statistically significant model. As a result of these findings, the hypothesis that terrain is a combat multiplier is not included in the theory of combat.

4. Combat Multiplier: Posture

The defender's posture was found to be highly significant in predicting battle outcomes, both by itself and in combination with certain other explanatory variables, particularly the tank ratio and surprise. The model results are shown for the combination of the tank ratio and posture in Table 6 and plotted in Figure 6 on page 25. A highly useful three factor model combining posture, the tank ratio and surprise will be used in the application example in Chapter V.

Table 6. MODEL RESULT FOR LOGLINEAR MODEL SUCCESS = TANK RATIO POSTURE

Response variable	Explanatory variables	P value of explanatory variables	P value of likelihood statistic
Attack success	Tank ratio	0.09	0.50
	Defender posture	0.15	

The observed data about posture, summarized in Table 7 on page 26 lends additional support to the plotted model. The one surprising result from a military perspective is that the probability of success against a hasty defense is lower than the probability of success against a prepared defense at any force ratio. Hasty defenses are characterized by a lower level of preparation (less than 24 hours) than prepared defenses. The key to understanding this phenomenon may lie in realizing that deliberate attacks are normally conducted against prepared and fortified postions because of their strength and time is made available for pre-attack preparations. Hasty attacks are usually conducted against hasty defenses due to the need to exploit a situation or when a decision is sought before reinforcements can arrive. In these situations it is possible that the defender can use the strength of the defense as a form of combat to reduce the attacker's chances of success.

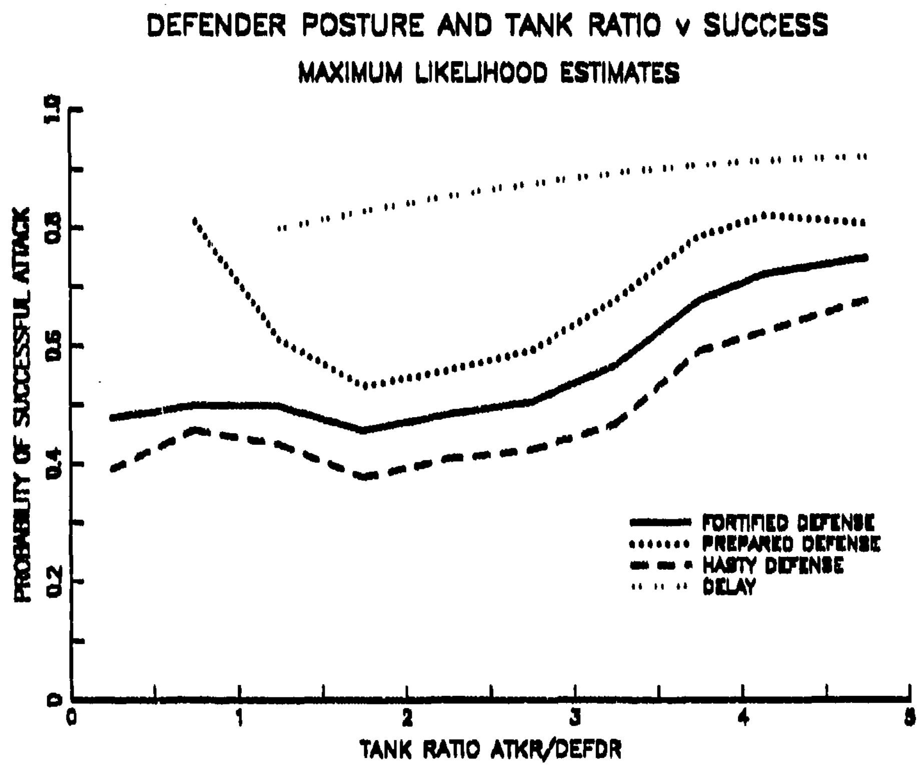

Figure 6. Defender Posture and Tank Ratio versus Success

Table 7. OBSERVED PROBABILITY OF SUCCESS BY POSTURE

Posture	P[success]	Number of observations
Delay	0.88	16
Fortified	0.63	98
Hasty Defense	0.52	60
Prepared	0.75	75

A careful observer will note that in Figure 6 on page 25 the probability of success against prepared defenses at about a 1:1 tank ratio does not follow the slope of the other curves. This may be attributed to about twelve data points in that region representing attacks in various campaigns of the Arab-Israeli conflicts. The recognized professionalism of the Israeli armored corps probably contributed to their success in attacking prepared positions at that force ratio; however, two of the battles were Egyptian successes during the initial crossing of the Suez Canal at the start of the 1973 war.

5. Combat Multiplier: Surprise

Surprise by itself was not found to be significant in determining battle outcomes, but contributed to models that included the tank ratio and posture.

Table 8. MODEL RESULT FOR LOGLINEAR MODEL SUCCESS = TANK RATIO SURPRISE

Response variable	Explanatory variables	P value of explanatory variables	P value of likelihood statistic
Attack success	Tank ratio	0.02	0.47
	Surprise	0.25	

Table 9 on page 28 indicates that historically a five to twelve percent increase in the probability of a successful attack can be gained by attaining some form of surprise, and reinforces the modeling result depicted in Figure 7 on page 27.

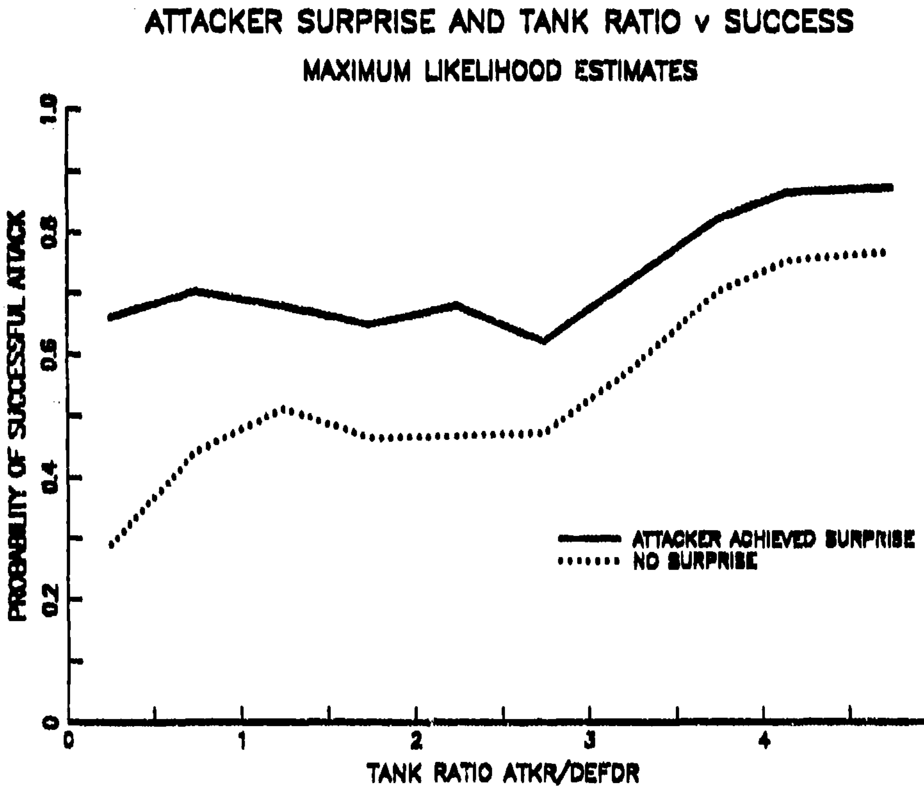

Figure 7. Attacker Surprise and Tank Ratio versus Success

Table 9. OBSERVED PROBABILITY OF SUCCESS BY POSTURE AND SURPRISE

Posture	Surprise	P[success]	Number of observations
Fortified Defense	Atkr	0.77	13
Fortified Defense	No	0.72	84
Hasty Defense	Atkr	0.58	12
Hasty Defense	No	0.52	46
Prepared Defense	Atkr	0.78	9
Prepared Defense	No	0.74	66

The manner in which surprise was achieved was not specified in the database, but the possibilities include surprise in the time of the attack, its location, the forces and tactics used, or the employment of a new technology.

D. SUMMARY

The method of falsification developed by Huber was explained as the means for the validation of the theory of combat. In short, deductively derived hypotheses about combat may be considered usable as long as historical research does not provide statistically significant evidence for their rejection. Each of the hypotheses was then modeled using the loglinear modeling of categorical data and the results were analyzed.

The traditional force ratios of attacking to defending troops and attacking to defending artillery pieces were not statistically significant in predicting battle outcomes, while the ratio of attacking to defending tanks was significant at the 0.05 level in predicting successful attacks. This suggests that the tank ratio is a statistically significant measure of combat power. The effect of the law of diminishing returns was seen in models that included the tank ratio as one of the explanatory variables. Terrain is not considered a combat multiplier for purposes of this theory of combat as it was shown to be not statistically significant. Surprise is a combat multiplier when considered with the tank ratio, while the defender's posture is the most significant of the combat multipliers. In Chapter V, a practical application of these results will be discussed.

V. APPLICATION TO THE PLANNING OF LAND COMBAT

A. INTRODUCTION

This chapter will illustrate an application of the theory of combat developed up to this point to the planning of a land combat operation in a contingency theater of operations. This application will use a three factor model which integrates the tank ratio, defender posture, and surprise as the variables predicting attack success.

Table 10. MODEL RESULT FOR LOGLINEAR MODEL SUCCESS = TANK RATIO POSTURE SURPRISE

Response variable	Explanatory variables	P value of explanatory variables	P value of likelihood statistic
Attack success	Tank ratio	0.03	0.62
	Defender posture	0.14	
	Surprise	0.13	

This model is highly significant relative to all of the models developed by this analysis and is the best of the three factor models. The model results are plotted in Figure 11 on page 35 and Figure 12 on page 36. The standard errors of the probability estimates range from 0.05 to 0.20. The regions defined by a one standard error distance from the plotted lines overlap adjacent regions through the range of the tank ratio. The regions overlap the estimated probabilities for adjacent levels of posture most notably in the areas of the 1.0 to 1.5 and the 4.0 to 4.5 tank ratios, which are also the regions where the slopes of the probability estimates change most rapidly.

B. A SCENARIO FOR DEMONSTRATION

The following scenario is used to demonstrate the potential of the theory of combat in examining two courses of action.

Situation. Sirocco, a country allied with the United States in promoting regional interests has been invaded by a neighboring country, Ekron, intent on seizing disputed territory. U.S. forces have been deployed to assist in repelling the attack of the belligerent neighbor. The neighboring country is well-armed with modern main battle tanks, armored personnel carriers, self-propelled artillery and aviation support. Siroccan forces are no longer capable of offensive action due to the surprise nature of the attack and an extraordinary effort to contain the enemy advance. Forces available to the U.S. III Corps commander are limited due to naval and air actions off the coast of Sirocco by another unfriendly power. The enemy forces that have crossed the international boundary are preparing defensive positions in the hope that a cease fire agreement will be negotiated, allowing them to annex the territory gained. The enemy forces in Sirocco are listed in Table 11, and do not include the sizeable reserve force located in Ekron. The U.S. ground forces available are listed in Table 12 on page 31, and the current dispositions of all forces are shown in Figure 8 on page 32.

Mission. The U.S. III Corps commander has been given the mission to attack and terminate the conflict on terms favorable to the U.S. and our Siroccan allies. The mission must be accomplished within the next 48 hours and with the forces currently on hand.

Courses of Action. The III Corps plans officer has developed two courses of action for analysis. The first, designated as Course of Action A, is represented in Figure 9 on page 33, and is an attack on two axes by armored brigades to destroy the enemy forces in sector. The western axis, designated as the main attack, is reinforced by the Corp's mechanized infantry brigade. One armored cavalry squadron will block movement by the 211 Infantry Regiment along the Portola-Webster highway, while the other cavalry squadron will follow the attack and block the other highway crossing the Ekron-Sirocco international boundary. Course of Action B, depicted in Figure 10 on page 34, is an attack on one axis with two armored brigades abreast to penetrate the enemy's defenses and secure positions cutting off his lines of communication. One of the cavalry squadrons secures the Webster-Portola highway, while the other blocks any advances toward Portola by the cut off enemy forces.

Table 11. ENEMY FORCES DEPLOYED IN SIROCCO

Unit	Symbol	Number of tanks
111 and 121 Armored Regiments, 2 TD		70 each
131 and 211 Mechanized Regiments, 2 TD		30 each
2 Tank Division Artillery Regiment		None

Table 12. U.S. FORCES AVAILABLE FOR EMPLOYMENT

Unit	Symbol	Number of tanks
1st and 3d Brigades, 2d Armored Division		100 each
2d Brigade (Mech), 2d Armored Division		50
Division Artillery, 2d Armored Division		None
1st and 2d Squadrons, 3d Armored Cavalry Regiment		40 each

C. APPLICATION OF THE THEORY

In order to analyze each course of action the plans officer must first establish what information is available and what assumptions will be made. He will use available intelligence information to estimate the enemy strength, the level of preparation of the enemy's defensive positions, and whether or not it is likely that some form of surprise will be achieved. This information is combined with the size of the attacking force on each axis of attack to estimate the force ratio. This is done for each course of action in succession. We can then use the modeling results in Figure 11 and Figure 12 to estimate the attack's probability of success based on the tank ratio, the defender's posture, and whether surprise is likely to be achieved.

In Course of Action A, the main attack, designated by the double arrow in Figure 9, has a ratio of attacking to defending tanks of approximately 1.5:1. If we identify the enemy's posture as prepared, and assess that surprise is unlikely, the attack's probability of success from Figure 12 is about 0.5 ± 0.1. The supporting attack by the 3d Brigade and a cavalry squadron has a 2:1 tank ratio, and under the same posture and surprise assumptions also has a probability of success of about 0.5 ± 0.1. If a means of achieving surprise were available, such as a night movement and a deception operation in the northern sector, Figure 11 would show the probabilities of success of the main and supporting attacks to be about 0.77 ± 0.1 and 0.82 ± 0.1 respectively. Differing assumptions about the defender posture would be handled in the same manner by referencing the appropriate line in Figures 11 and 12.

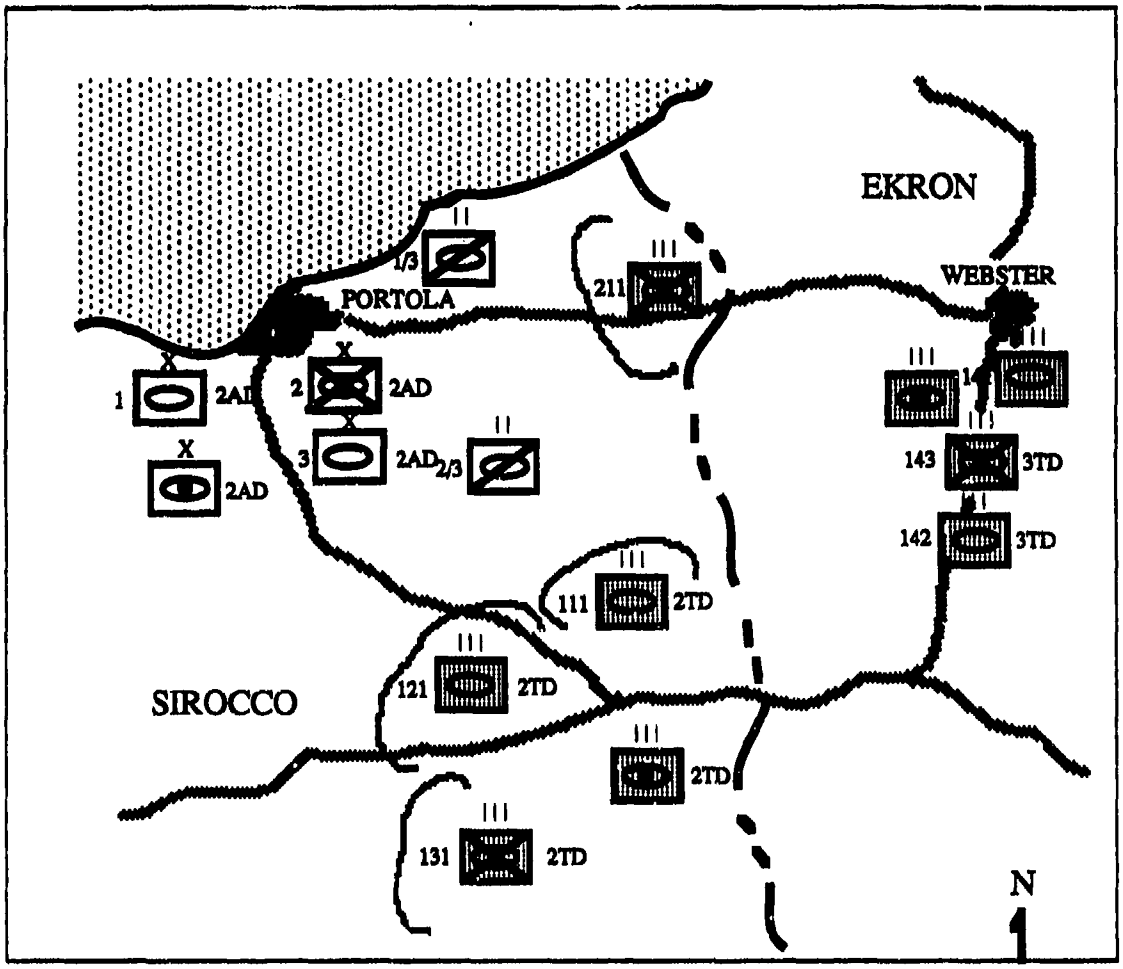

Figure 8. Operational Situation

Course of Action B, illustrated in Figure 10, concentrates the available forces against one enemy regiment, achieving a tank ratio of 3.5:1. If surprise is possible and if the enemy's posture is prepared, the probability of success from Figure 11 is 0.9 ± 0.05. The probability of success from Figure 12 is 0.7 ± 0.15 if surprise is unlikely to be attained. We also note from the plot that the point of diminishing marginal returns is reached at about the 3.5:1 ratio for this level of defender posture. To the planner this would imply that if additional forces were available they would be more effectively used in efforts that were not at the point of diminishing returns. The planner would now have the estimated probabilities of success based on historical experience to consider along with other factors in evaluating which course of action will best accomplish the mission. If all other

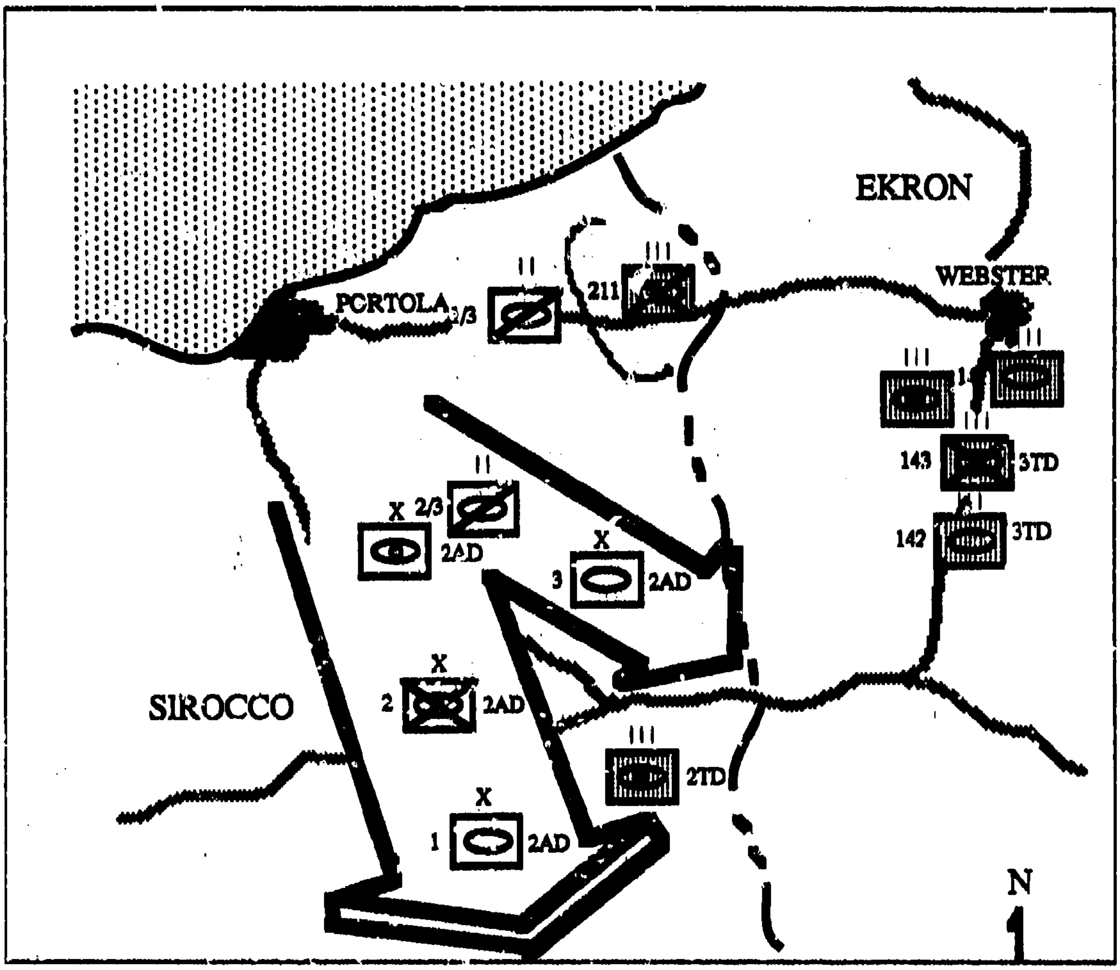

Figure 9. Course of Action A

considerations were equal, the planner should choose course of action B, the plan with the greatest probabililty of success.

The laws of probability can be used to extend the usefulness of the model used in this chapter. For instance, the joint probability of success of two simultaneous attacks is the product of the two probabilities, if the operations are independent of each other. The probability of a successful defense is one minus the probability of a successful attack. If defensive operations are being planned, the tank ratio used in the model is still the ratio of attacking to defending tanks. In this case the defensive planner must estimate the number of enemy tanks in the formation that will oppose him and whether the attacker can achieve surprise as to the time and place of the attack. A conservative

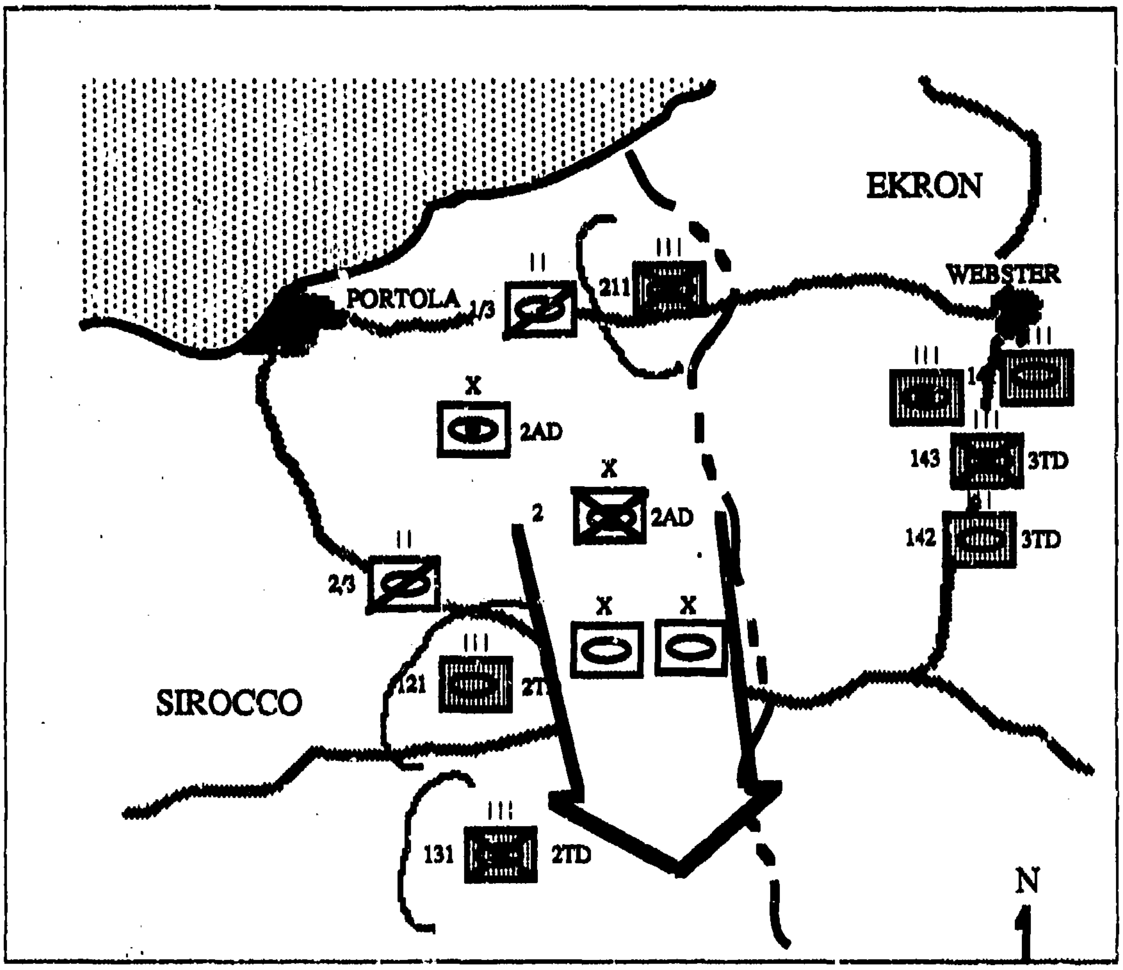

Figure 10. Course of Action B

planner may start with the assumption that the attacker will intially achieve surprise, then evaluate his alternatives from that assumption. The planner will know his own level of preparation and can then make an estimate of the probability of the attacker's success, or the estimate of his defense's success by subtracting the attack probability from one. It should be reemphasized at this point that this model was developed from data about combat at the brigade/regiment level and higher, and as such the validity of the model in estimating probabilities for combat at lower levels is not established.

D. SUMMARY

This chapter has illustrated the use of a model that was highly significant in explaining the outcome of historical battles. This model was used to estimate the

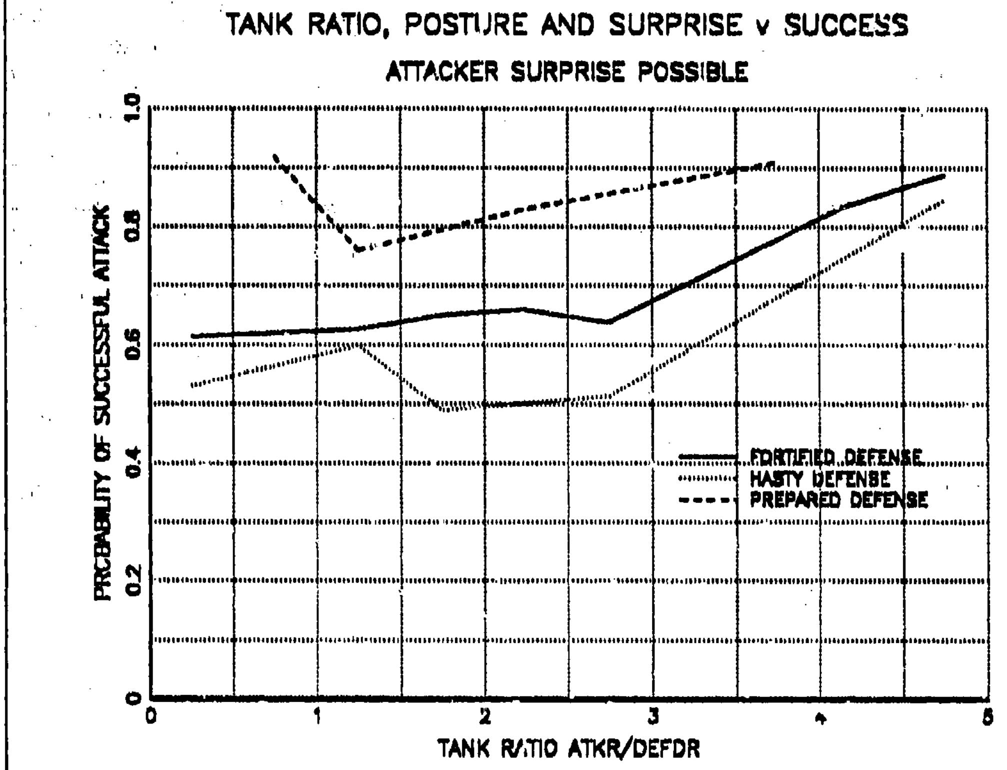

Figure 11. Tank Ratio and Posture versus Success (Surprise Possible)

probability of success of offensive operations, and its use for evaluating defensive courses of action was also explained. While this model cannot be used alone to evaluate operational plans, it provides a quantitative means to supplement military judgment. The next chapter concludes with a summary of the research findings and recommendations for further study.

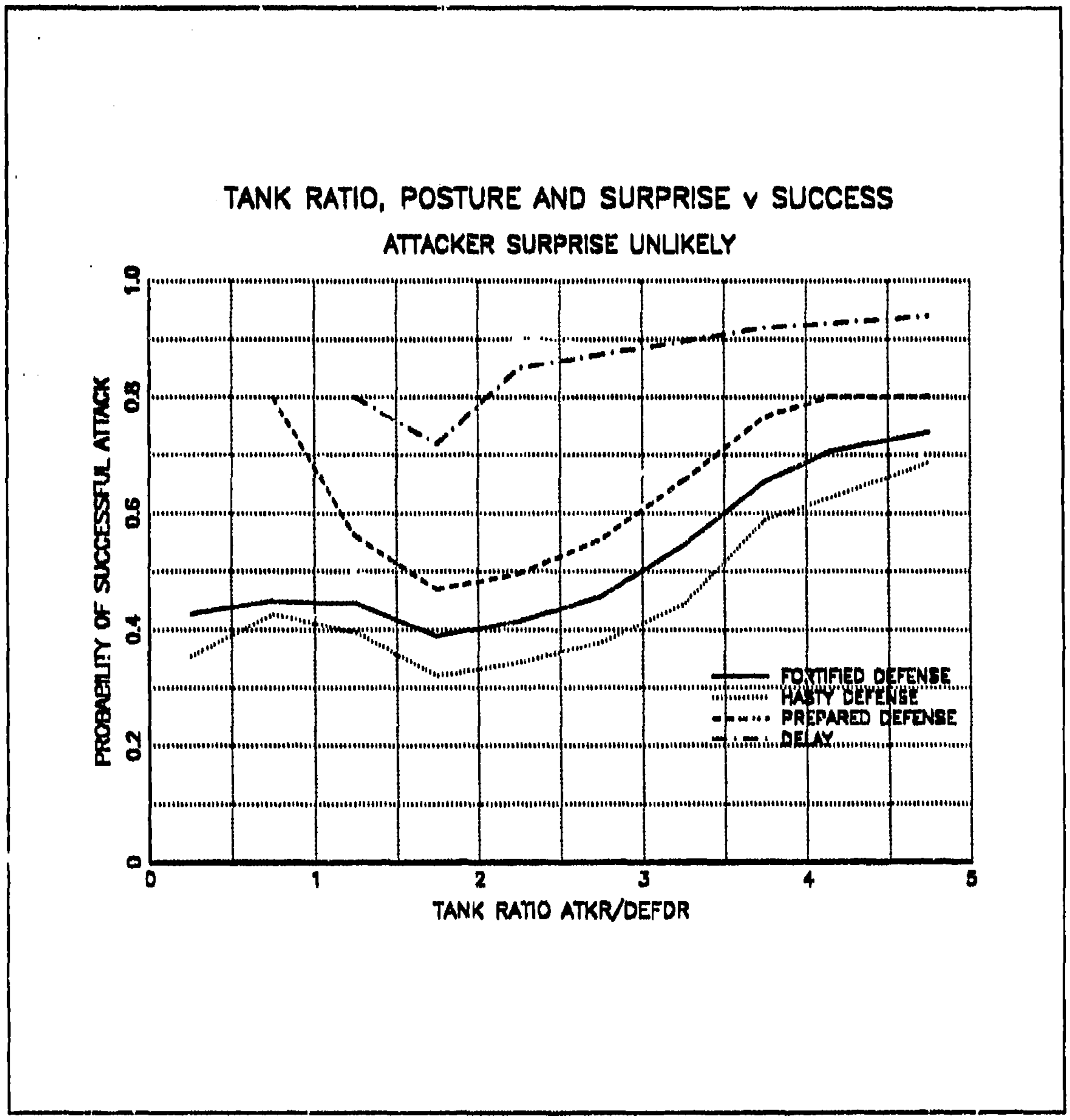

Figure 12. Tank Ratio and Posture versus Success (Surprise Unlikely)

VI. CONCLUSIONS

A. THE THEORY AND MODEL FOR THE PLANNING OF LAND COMBAT

The focus of this thesis was a method of comparing alternative courses of action based on a quantitative evaluation of the estimated probability of success of each. The scope was the planning of land combat at the brigade through corps levels. A theory of combat was used to organize fundamental laws about combat and explain the interaction of combat forces and processes. These laws of combat were hypotheses confirmed by historical data, military judgment and formal models.

The method of falsification developed by Huber was explained as the means for the validation of the theory of combat. In short, deductively derived hypotheses about combat may be considered usable as long as historical research does not provide statistically significant evidence for their rejection. Each of the hypotheses was then modeled using the loglinear modeling of categorical data and the results were analyzed. The data characterized 260 combined arms battles that occurred during the period 1937 through 1982.

The traditional force ratios of attacking to defending troops and attacking to defending artillery pieces were not statistically significant in predicting battle outcomes, while the ratio of attacking to defending tanks was significant at the 0.05 level in predicting successful attacks. This suggests that the tank ratio is a statistically significant measure of combat power. The effect of the law of diminishing returns was seen in graphs of attack success probabilities that included the tank ratio as one of the explanatory variables. Terrain is not considered a combat multiplier for purposes of this theory of combat as it was not shown to be statistically significant. Surprise is a combat multiplier when considered with the tank ratio, while the defender's posture is the most significant of the combat multipliers. In Chapter V, a practical application of these laws of combat was illustrated.

B. IMMEDIATE APPLICATIONS TO MILITARY PLANNING

The theory and models addressed in this research could be incorporated into current doctrinal and instructional manuals as a means of modeling combat power and assessing courses of action. These manuals and courses of instruction could include the Command and General Staff College's *ST 100-9 The Command Estimate* and *ST 100-3 Battle Book*, as well as instruction in brigade level operations conducted at the Army's combat arms schools. Additionally, the tables containing observed data and probabilities of success in Chapter IV and Appendix A give some insights into the effects of posture, surprise, and attacker-defender combinations on combat outcomes. These tables and the plots of modeling results can also be used as a "benchmark" to compare highly aggregated combat models with historical combat.

C. RECOMMENDATIONS FOR FURTHER STUDY

The methodology developed in Chapter III could be used to further analyze the Benchmark database. The categorical modeling of battle outcomes (e.g. penetration, withdrawl, breakthru) using explanatory variables including tactics and posture could validate additional hypotheses to be included in the theory of combat developed in this thesis. The data may also be analyzed to validate current tables of advance rates, casualty rates, and equipment loss rates or to develop new tables. In addition, some testing could be done to determine if these types of loss and advance rates can be reliably modeled. One further area of interest would be the examination of the effect of attacker and defender frontage and defensive position depth on battle outcome. This study might reveal more about the effects of economy of force and diminishing returns on combat power and battle outcomes.

APPENDIX A. PROBABILITIES OF SUCCESS BY NATIONAL FORCE AND POSTURE

These tables display the observed probabilities of successful attacks by various combinations of attacking and defending forces and defender posture. Posture was found to be highly significant in predicting battle outcome when combined with data about the national force attacking or defending. Cells that contain dashed entries had fewer than five observations in them and are not displayed to avoid misinterpretation.

Table 13. OBSERVED PROBABILITY OF SUCCESS BY ATTACKING FORCE AND POSTURE

Attacker	Defender Posture			
	Fortified Defense	Prepared Defense	Hasty Defense	Delay
British	0.58	0.75	0.80	-
Egyptian	-	-	0.33	-
German	-	0.54	0.17	-
Israeli	0.77	0.83	0.81	-
U.S.	0.59	0.89	0.78	0.86
U.S.S.R.	0.78	0.90	-	-

Table 14. OBSERVED PROBABILITY OF SUCCESS BY DEFENDING FORCE AND POSTURE

Defender	Defender Posture			
	Fortified Defense	Prepared Defense	Hasty Defense	Delay
British	-	0.14	0.20	-
Egyptian	0.80	0.89	0.70	-
German	0.58	0.84	0.75	0.80
Israeli	-	0.43	0.20	-
Japanese	0.64	-	-	-
Syrian	0.74	0.99	-	-
U.S.	-	-	0.09	-
U.S.S.R.	-	0.60	-	-

Table 15. OBSERVED PROBABILITY OF SUCCESS BY ATTACKING AND DEFENDING FORCE

Attacker	Defender	P[success]
German	British	0.36
British	German	0.62
Egyptian	Israeli	0.50
German	U.S.	0.11
German	U.S.S.R.	0.67
Israeli	Egyptian	0.81
Israeli	Jordanian	0.71
Israeli	Syrian	0.86
Syrian	Israeli	0.22
U.S.	German	0.67
U.S.	Chinese	0.99
U.S.	Japanese	0.70
U.S.S.R.	German	0.87

APPENDIX B. EXTRACT FROM BENCHMARK DATABASE

Row	Theater	Name	Atkr	Defdr	Atkr echelon	Defdr echelon	Terrain	Cover
1								
2	Spain	Guadalajara	Ital	SRpb	Army	Army	Flat	Bare
3								
4	France	Ardennes	Ger	Fr	ArGp	Army	Rolling	Mixed
5	France	Sedan	Ger	Fr	Corp	Army	Rolling	Mixed
6	France	Cambrai	Ger	Fr	Div	Div	Rolling	Mixed
7	France	Arras	Brit	Ger	Rgt	Rgt	Rolling	Mixed
8	France	Boos	Fr	Ger	Co	Co	Rolling	Mixed
9								
10	Manchuria	Changkufeng 1	Jap	USSR	Rgt	Rgt	Rugged	Bare
11	Manchuria	Changkufeng 2	USSR	Jap	Div	Div	Rugged	Bare
12	Manchuria	Changkufeng 3	USSR	Jap	Army	Div	Rugged	Bare
13	Manchuria	Nomonhan 1	Jap	USSR	Rgt	Rgt	Rolling	Bare
14	Manchuria	Nomonhan 2	USSR	Jap	Army	Army	Rolling	Bare
15	Manchuria	Mutankiang	USSR	Jap	Army	Corp	Rugged	Mixed
16								
17	Malaysia	Jitra	Brit	Jap	Div	Div	Rolling	Wooded
18								
19	Finland	Suomussalmi	Finn	USSR	Div	Corp	Rolling	Wooded
20	Russia	Rovno	Ger	USSR	Army	ArGp	Rolling	Mixed
21	Russia	Moscow Defense	Ger	USSR	ArGp	ArGp	Rolling	Mixed
22	Russia	Moscow Counterattack	USSR	Ger	ArGp	ArGp	Rolling	Mixed
23	Russia	Pogoreloye	USSR	Ger	Army	Army	Flat	Swamp
24								
25	N.Africa	Alam Halfa	Ger+	Brit	Army	Army	Flat	Bare
26	N.Africa	Alamein 2	Brit	Ger+	Army	Army	Flat	Bare
27	N.Africa	Alamein-Lightfoot	Brit	Ger+	Army	Army	Flat	Bare
28	N.Africa	Alamein-Bridgehead	Brit	Ger+	Army	Army	Flat	Bare
29	N.Africa	Alamein-Supercharge	Brit	Ger+	Army	Army	Flat	Bare
30	N.Africa	Chouigui Pass	Ger	US	Bn	Co	Rolling	Bare
31	N.Africa	El Guettar 3	Ger	US	Div	Div	Rolling	Bare
32	N.Africa	Sedjanne-Bizerte	US	Ger	Div	Div	Rugged	Mixed
33								
34	Italy	Amphitheater	Brit	Ger	Div	Rgt	Rolling	Mixed
35	Italy	Port of Salerno	Brit	Ger	Div	Rgt	Rolling	Mixed
36	Italy	Sele-Calore Corridor	US	Ger	Div	Div	Rolling	Mixed
37	Italy	Battipaglia 1	Ger	Brit	Div	Div	Rolling	Mixed
38	Italy	Vietri 1	Ger	Brit	Div	Div	Rolling	Mixed
39	Italy	Tobacco Factory	Ger	Brit	Div	Div	Rolling	Mixed
40	Italy	Battipaglia 2	Brit	Ger	Div	Rgt	Rolling	Mixed
41	Italy	Eboli	US	Ger	Div	Div	Rolling	Mixed
42	Italy	Vietri 2	Ger	Brit	Div	Div	Rolling	Mixed
43	Italy	Grazzanise	Brit	Ger	Div	Div	Flat	Mixed
44	Italy	Caiazzo	US	Ger	Div	Div	Rolling	Mixed
45	Italy	Capua	Brit	Ger	Div	Div	Flat	Mixed
46	Italy	Castel Volturno	Brit	Ger	Div	Div	Flat	Mixed
47	Italy	Monte Acero	US	Ger	Div	Div	Rugged	Mixed

48	Italy	Triflisco	US	Ger	Div	Div	Rolling	Mixed
49	Italy	Dragoni	US	Ger	Div	Div	Rolling	Mixed
50	Italy	Canal 1	Brit	Ger	Div	Div	Flat	Mixed
51	Italy	Monte Grande (V)	Brit	Ger	Rgt	Rgt	Rolling	Mixed
52	Italy	Canal 2	Brit	Ger	Div	Rgt	Rolling	Mixed
53	Italy	Francolise	Brit	Ger	Div	Rgt	Rolling	Mixed
54	Italy	S. Maria Oliveto	US	Ger	Div	Div	Rolling	Mixed
55	Italy	Monte Camino 1	Brit	Ger	Div	Rgt	Rugged	Mixed
56	Italy	Monte Lungo	US	Ger	Div	Rgt	Rugged	Mixed
57	Italy	Pozzilli	US	Ger	Div	Div	Rugged	Mixed
58	Italy	Monte Camino 2	Ger	Brit	Rgt	Rgt	Rugged	Mixed
59	Italy	Monte Rotondo	US	Ger	Div	Rgt	Rugged	Mixed
60	Italy	Calabritto	Brit	Ger	Div	Div	Rugged	Mixed
61	Italy	Monte Camino 3	Brit	Ger	Div	Rgt	Rugged	Mixed
62	Italy	Monte Maggiore	US	Ger	Div	Rgt	Flat	Mixed
63	Italy	Aprilia 1	Brit	Ger	Div	Div	Flat	Mixed
64	Italy	Factory 1	Ger	Brit	Div	Div	Rolling	Mixed
65	Italy	Campoleone 2	Ger	Brit	Div	Rgt	Flat	Mixed
66	Italy	Campoleone 1	Brit	Ger	Div	Div	Flat	Mixed
67	Italy	Carroceto	Ger	Brit	Div	Div	Flat	Mixed
68	Italy	Moletta River 1	Ger	Brit	Div	Div	Flat	Mixed
69	Italy	Aprilia 2	Ger	Brit	Div	Div	Flat	Mixed
70	Italy	Factory 2	US	Ger	Div	Div	Flat	Mixed
71	Italy	"Bowling Alley" 1	Ger	US	Corp	Div	Flat	Mixed
72	Italy	Moletta River 2	Ger	Brit	Div	Div	Flat	Mixed
73	Italy	Fioccia	Ger	US	Div	Div	Flat	Mixed
74	Italy	S. Maria Infante	US	Ger	Div	Div	Rugged	Bare
75	Italy	San Martino	US	Ger	Div	Div	Rugged	Bare
76	Italy	Castellonorato	US	Ger	Div	Div	Rugged	Bare
77	Italy	Spigno	US	Ger	Div	Div	Rugged	Bare
78	Italy	Formia	US	Ger	Div	Div	Rugged	Bare
79	Italy	Monte Grande (R)	US	Ger	Div	Div	Rolling	Mixed
80	Italy	Itri-Fondi	US	Ger	Div	Div	Rugged	Mixed
81	Italy	Terracina	US	Ger	Div	Div	Rugged	Mixed
82	Italy	Moletta River 3	Brit	Ger	Div	Div	Flat	Mixed
83	Italy	Anzio-Albano Road 2	Brit	Ger	Div	Div	Flat	Mixed
84	Italy	Anzio Breakout	US	Ger	Div	Div	Flat	Mixed
85	Italy	Cisterna	US	Ger	Div	Div	Flat	Mixed
86	Italy	Sezze	US	Ger	Div	Rgt	Rolling	Mixed
87	Italy	Velletri	US	Ger	Div	Div	Rolling	Mixed
88	Italy	Campoleone (Station)	US	Ger	Div	Div	Rolling	Mixed
89	Italy	Villa Crocetta	US	Ger	Div	Div	Rolling	Mixed
90	Italy	Ardea	Brit	Ger	Div	Div	Rolling	Mixed
91	Italy	Fosso di Campoleone	US	Ger	Corp	Div	Rolling	Mixed
92	Italy	Lanuvio	US	Ger	Div	Div	Rolling	Mixed
93	Italy	Lariano	US	Ger	Div	Div	Rolling	Mixed
94	Italy	Via Anziate	US	Ger	Div	Div	Rolling	Bare
95	Italy	Valmontone	US	Ger	Div	Div	Rolling	Mixed
96	Italy	Tarto-Tiber	Brit	Ger	Corp	Div	Flat	Mixed
97	Italy	Il Giogio Pass	US	Ger	Div	Rgt	Rugged	Mixed
98								
99	W.Europe	Saint Lo	US	Ger	Div	Div	Rolling	Mixed
100	W.Europe	"Goodwood"	Brit	Ger	Army	Corp	Rolling	Mixed
101	W.Europe	"Cobra"	US	Ger	Corp	Corp	Rolling	Mixed
102	W.Europe	Mortain	Ger	US	Corp	Div	Rolling	Mixed
103	W.Europe	Chartres	US	Ger	Div	Army	Rolling	Mixed
104	W.Europe	Melun	US	Ger	Div	Div	Rolling	Mixed

105	W.Europe	Seine River	US	Ger	Corp	Div	Rolling	Mixed
106	W.Europe	Moselle-Metz	US	Ger	Corp	Army	Rolling	Mixed
107	W.Europe	Metz	US	Ger	Corp	Army	Rolling	Mixed
108	W.Europe	Arracourt	Ger	US	Div	Rgt	Rolling	Mixed
109	W.Europe	Westwall	US	Ger	Corp	Corp	Rolling	Mixed
110	W.Europe	Schmidt	US	Ger	Div	Corp	Rolling	Mixed
111	W.Europe	Seille-Nied	US	Ger	Corp	Corp	Rolling	Mixed
112	W.Europe	Chateau Salins	US	Ger	Corp	Div	Rolling	Mixed
113	W.Europe	Morhange	US	Ger	Div	Div	Rolling	Mixed
114	W.Europe	Morhange-Faulquemont	US	Ger	Corp	Corp	Rolling	Mixed
115	W.Europe	Bourgaltroff	US	Ger	Div	Div	Rolling	Mixed
116	W.Europe	Sarre-St. Avold	US	Ger	Corp	Corp	Rolling	Mixed
117	W.Europe	Baerendorf 1	US	Ger	Div	Div	Rolling	Mixed
118	W.Europe	Baerendorf 2	US	Ger	Div	Div	Rolling	Mixed
119	W.Europe	Burbach-Durstel	US	Ger	Div	Div	Rolling	Mixed
120	W.Europe	Durstel-Faerbersville	US	Ger	Corp	Corp	Rolling	Mixed
121	W.Europe	Sarre-Union	US	Ger	Div	Div	Rolling	Mixed
122	W.Europe	Sarre-Singling	US	Ger	Corp	Corp	Rolling	Mixed
123	W.Europe	Singling-Bining	US	Ger	Div	Div	Rolling	Mixed
124	W.Europe	Sauer River	Ger	US	Div	Rgt	Rugged	Mixed
125	W.Europe	Saint Vith	Ger	US	Corp	Div	Rolling	Mixed
126	W.Europe	Bastogne	Ger	US	Corp	Rgt	Rolling	Mixed
127								
128	E.Europe	Leningrad-"Spark"	USSR	Ger	Army	Army	Flat	Mixed
129	E.Europe	Kursk-Oboyan 1	Ger	USSR	Corp	Army	Rolling	Mixed
130	E.Europe	Kursk-South [???]	Ger	USSR	Army	ArGp	Rolling	Mixed
131	E.Europe	Kursk-Oboyan 2	Ger	USSR	Corp	Army	Rolling	Mixed
132	E.Europe	Kursk-Oboyan 3	Ger	USSR	Corp	Army	Rolling	Mixed
133	E.Europe	Kursk-Prokhorovka	USSR	Ger	ArGp	Corp	Rolling	Mixed
134	E.Europe	Kursk Counterattack	USSR	Ger	ArGp	Army	Rolling	Mixed
135	E.Europe	Kursk-Belgorod	USSR	Ger	Army	Div	Rolling	Mixed
136	E.Europe	Melitopol	USSR	Ger	ArGp	Army	Rolling	Mixed
137	E.Europe	Korsun-Schevkovskiy	USSR	Ger	ArGp	Army	Flat	Mixed
138	E.Europe	Nikopol Bridgehead	USSR	Ger	Div	Div	Flat	Mixed
139	E.Europe	Sevastopol	USSR	Ger	ArGp	Army	Rolling	Urban
140	E.Europe	Berezina River	USSR	Ger	Corp	Div	Flat	Swamp
141	E.Europe	Lvov-Sandomierz	USSR	Ger	ArGp	ArGp	Flat	Mixed
142	E.Europe	Brody 1	USSR	Ger	Corp	Rgt	Flat	Swamp
143	E.Europe	Brody 2	USSR	Ger	Corp	Div	Flat	Swamp
144	E.Europe	Vistula Crossing 1	USSR	Ger	Corp	Div	Flat	Mixed
145	E.Europe	Vistula Crossing 2	USSR	Ger	Corp	Corp	Flat	Mixed
146	E.Europe	Targul Frumos	USSR	Ger	Army	Div	Flat	Bare
147	E.Europe	Yassy-Kishinev	USSR	Ger	ArGp	ArGp	Flat	Mixed
148	E.Europe	Vistula-Oder	USSR	Ger	ArGp	ArGp	Flat	Mixed
149	E.Europe	East Prussia	USSR	Ger	ArGp	ArGp	Rolling	Mixed
150	E.Europe	Ciechanow 1	USSR	Ger	Div	Div	Rolling	Bare
151	E.Europe	Ciechanow 2	USSR	Ger	Div	Div	Rolling	Bare
152	E.Europe	Seelow Heights	USSR	Ger	Div	Rgt	Rugged	Mixed
153								
154	Pacific	Tarawa-Betio	US	Jap	Div	Rgt	Rolling	Mixed
155	Pacific	Iwo Jima 1	US	Jap	Corp	Div	Rolling	Bare
156	Pacific	Iwo Jima-Mt Suribachi	US	Jap	Rgt	Rgt	Rugged	Bare
157	Pacific	Iwo Jima 3	US	Jap	Corp	Rgt	Rolling	Bare
158	Pacific	Okinawa Beach 1	US	Jap	Div	Rgt	Flat	Mixed
159	Pacific	Okinawa Outposts	US	Jap	Div	Rgt	Rugged	Mixed
160	Pacific	Tomb Hill-Ouki	US	Jap	Div	Rgt	Rugged	Mixed
161	Pacific	Skyline Ridge	US	Jap	Div	Rgt	Rugged	Mixed

162	Pacific	Kochi Ridge-Onaga 1	US	Jap	Div	Rgt	Rugged	Mixed
163	Pacific	Kochi Ridge-Onaga 2	US	Jap	Div	Rgt	Rugged	Mixed
164	Pacific	Kochi Ridge-Onaga 3	US	Jap	Div	Rgt	Rugged	Mixed
165	Pacific	Kochi Counterattack	Jap	US	Div	Rgt	Rugged	Mixed
166	Pacific	Kochi Ridge 4	US	Jap	Div	Div	Rugged	Mixed
167	Pacific	Shuri West 1	US	Jap	Div	Rgt	Rugged	Mixed
168	Pacific	Shuri Counterattack	Jap	US	Div	Div	Rolling	Mixed
169	Pacific	Shuri West 2	US	Jap	Div	Div	Rugged	Mixed
170	Pacific	Shuri West 3	US	Jap	Div	Div	Rugged	Mixed
171	Pacific	Hill-95 1	US	Jap	Div	Rgt	Rugged	Mixed
172	Pacific	Hill-95 2	US	Jap	Div	Rgt	Rugged	Mixed
173	Pacific	Yaeju Dake	US	Jap	Div	Rgt	Rugged	Mixed
174	Pacific	Hills 153 & 115	US	Jap	Div	Rgt	Rugged	Mixed
175	Pacific	Okinawa Beach 2	US	Jap	Div	Rgt	Rolling	Mixed
176	Pacific	Shuri Advance	US	Jap	Div	Rgt	Rolling	Mixed
177	Pacific	Kakazu & Tombstone	US	Jap	Div	Rgt	Rolling	Mixed
178	Pacific	Nishibaru Ridge	US	Jap	Div	Rgt	Rolling	Mixed
179	Pacific	Maeda Escarpment	US	Jap	Div	Div	Rolling	Mixed
180	Pacific	Shuri East 1	US	Jap	Div	Div	Rolling	Mixed
181	Pacific	Shuri East 2	US	Jap	Div	Div	Rolling	Mixed
182	Pacific	Shuri East 3	US	Jap	Div	Div	Rolling	Mixed
183	Pacific	Yuza Dake Approach	US	Jap	Div	Div	Rolling	Mixed
184	Pacific	Yuza Dake Attack	US	Jap	Div	Div	Rolling	Mixed
185	Pacific	Yuza Dake Capture	US	Jap	Div	Rgt	Rolling	Mixed
186								
187	Viet Nam	Quang Tri	NVN	SVN	Corp	Div	Flat	Mixed
188								
189	Korea	Pusan Perimeter	NKor	US	Corp	Div		
190	Korea	Pusan Breakout	US	NKor	Div	Corp		
191	Korea	Nam River	US	China	Div	Army		
192	Korea	Kunsan	US	China	Div	Army		
193	Korea	Han River	US	China	Div	Army		
194	Korea	Butte Line	US	China	Div	Army		
195	Korea	Chan River	US	China	Div	Army		
196	Korea	Kansas Line	China	US	Army	Div		
197	Korea	Pierce Line	US	China	Div	Army		
198	Korea	Iron Triangle	China	US	Army	Div		
199	Korea	Bayonette Line	US	China	Div	Army	Rugged	
200								
201	W.Bank	Jerusalem "Jebussi"	Is	Jor	Rgt	Rgt	Rugged	Mixed
202	W.Bank	Jerusalem Corridor	Is	Jor	Div	Rgt	Rolling	Bare
203	Golan	Mishmar Hayarden 1	Syr	Is	Rgt	Rgt	Flat	Mixed
204	Golan	Mishmar Hayarden 2	Syr	Is	Rgt	Rgt	Flat	Mixed
205	Golan	Hiram	Is	Syr	Div	Rgt	Rolling	Bare
206	Sinai	Acre	Is	Egy	Rgt	Rgt	Flat	Mixed
207	Sinai	"Death to Invader"	Is	Egy	Rgt	Rgt	Rolling	Bare
208	Sinai	El Auja "Ayin"	Is	Egy	Div	Div	Flat	Bare
209	Sinai	Ageila-Rafah "Ayin"	Is	Egy	Div	Div	Flat	Bare
210								
211	Sinai	Abu Agelia-Um Katef	Is	Egy	Div	Rgt	Flat	Bare
212	Sinai	Bir Rud Salim	Is	Egy	Rgt	Rgt	Flat	Bare
213	Sinai	Rafah-El Arish	Is	Egy	Div	Div	Flat	Bare
214	Sinai	Gaza-Khan Yunis	Is	Egy	Rgt	Rgt	Flat	Urban
215								
216	W.Bank	Jenin	Is	Jor	Div	Rgt	Rugged	Mixed
217	W.Bank	Jerusalem	Is	Jor	Corp	Rgt	Rugged	Mixed
218	W.Bank	Katibiya	Is	Jor	Rgt	Rgt	Rugged	Mixed

219	W.Bank	Tiflit-Zababiya	Is	Jor	Rgt	Rgt	Rugged	Mixed
220	W.Bank	Nablus	Is	Jor	Div	Div	Rugged	Mixed
221								
222	Jordan	Karama	Is	Jor	Div	Div	Flat	Mixed
223								
224	Sinai	Rafah	Is	Egy	Div	Div	Flat	Desert
225	Sinai	Bir Lahfan	Is	Egy	Div	Div	Flat	Desert
226	Sinai	Abu Ageila-Um Katef	Is	Egy	Div	Div	Flat	Mixed
227	Sinai	El Arish	Is	Egy	Div	Div	Flat	Desert
228	Sinai	Jebel Libni	Is	Egy	Div	Div	Flat	Desert
229	Sinai	Gaza Strip	Is	PLO	Div	Div	Flat	Mixed
230	Sinai	Bir Hassna-Thamada	Is	Egy	Div	Div	Flat	Desert
231	Sinai	Mitla Pass	Egy	Is	Div	Div	Flat	Desert
232	Sinai	Bir Hama-Bir Gifgafa	Is	Egy	Div	Div	Flat	Desert
233	Sinai	Nakhl	Is	Egy	Div	Div	Flat	Desert
234	Sinai	Bir Gifgafa	Egy	Is	Rgt	Rgt	Flat	Desert
235								
236	Golan	Tel Fahar-Banias	Is	Syr	Rgt	Rgt	Rugged	Mixed
237	Golan	Rawiyeh	Is	Syr	Rgt	Rgt	Rugged	Mixed
238	Golan	Zaoura-Kala	Is	Syr	Rgt	Rgt	Rugged	Mixed
239	Golan	Banias-Massada	Is	Syr	Rgt	Rgt	Rugged	Mixed
240	Golan	Kuneitra	Is	Syr	Div	Div	Rugged	Mixed
241	Golan	Boutmiya	Is	Syr	Div	Div	Rugged	Mixed
242								
243	Sinai	Suez Canal-North	Egy	Is	Corp	Div	Rolling	Desert
244	Sinai	Suez Buildup-North	Egy	Is	Corp	Div	Rolling	Desert
245	Sinai	Suez Canal-South	Egy	Is	Corp	Rgt	Rolling	Desert
246	Sinai	Suez Buildup-South	Egy	Is	Corp	Div	Rolling	Desert
247	Sinai	Kantara Firdan	Is	Egy	Div	Corp	Rolling	Desert
248	Sinai	Suez Attack-North	Egy	Is	Corp	Corp	Rolling	Desert
249	Sinai	Suez Attack-South	Egy	Is	Corp	Corp	Rolling	Desert
250	Sinai	Chinese Farm 1	Is	Egy	Div	Corp	Rolling	Desert
251	Sinai	Chinese Farm 2	Is	Egy	Div	Corp	Rolling	Desert
252	Sinai	Chinese Farm-West	Is	Egy	Div	Div	Rolling	Desert
253	Sinai	Ismailia	Is	Egy	Div	Div	Rolling	Desert
254	Sinai	Jebel Geneifa	Is	Egy	Div	Corp	Rolling	Desert
255	Sinai	Shallufa 1	Is	Egy	Div	Corp	Rolling	Desert
256	Sinai	Shallufa 2	Is	Egy	Div	Corp	Rolling	Desert
257	Sinai	Suez [City]	Is	Egy	Div	Corp	Rolling	Desert
258	Sinai	Adabiya	Is	Egy	Div	Corp	Rolling	Desert
259								
260	Golan	Kuneitra 2	Syr	Is	Div	Rgt	Rugged	Bare
261	Golan	Ahmadiyeh	Syr	Is	Div	Rgt	Rugged	Bare
262	Golan	Rafid	Syr	Is	Div	Rgt	Rugged	Bare
263	Golan	Yehuda el Al	Syr	Is	Div	Div	Rugged	Bare
264	Golan	Nafakh	Syr	Is	Div	Rgt	Rugged	Bare
265	Golan	Tel Faris	Is	Syr	Div	Div	Rugged	Bare
266	Golan	Hushniyah	Is	Syr	Div	Div	Rugged	Bare
267	Golan	Mount Hermonit	Syr	Is	Div	Rgt	Rugged	Bare
268	Golan	Mount Hermon 1	Is	Syr	Rgt	Rgt	Rugged	Bare
269	Golan	Tel Shams	Is	Syr	Div	Div	Rugged	Bare
270	Golan	Tel Shaar	Is	Syr	Div	Div	Rugged	Bare
271	Golan	Tel el Hara	Irq	Is	Div	Div	Rugged	Bare
272	Golan	Kfar Shams-Tel Antar	Is	Irq	Div	Div	Rugged	Bare
273	Golan	Naba	Jor	Is	Div	Rgt	Rugged	Bare
274	Golan	Golan Counterattack	Syr	Is	Div	Div	Rugged	Bare
275	Golan	Mount Hermon 2	Is	Syr	Rgt	Rgt	Rugged	Mixed

276	Golan	Mount Herman 3	Is	Syr	Rgt	Rgt	Rugged	Mixed
277								
278	Lebanon	Bekka Valley	Is	Syr	Corp	Div	Rolling	Desert
279								

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************************************************************************************
* Row Surprise Defender        Success Atkr      Atkr   Atkr   Defdr      Defdr  Defdr  *
*              posture                 troops    tanks  arty   troops     tanks  arty   *
************************************************************************************
    1
    2   Atkr   Prepared        Dfdr        52000      50    230     100000     70
    3
    4                          Atkr                 2439                     2160
    5   Atkr   Prepared        Atkr        48000     756    202      60000    200    192
    6                          Atkr        17000     218             12143    238
    7   No     Hasty           Dfdr        11821      88      0      18000    218
    8   No     Prepared        Tie           189      14      0        189     10
    9
   10   No     Fortified       Atkr         1410             14       1460     20     20
   11   No     Fortified       Dfdr         4000      30     40       3010      0     22
   12   No     Fortified       Dfdr        20000     200    100       8000      0     37
   13   No     Hasty           Both         1300      10      4       1228      0     14
   14   Atkr   Fortified       Atkr        57000     498    216      30000    120    135
   15   Atkr   Fortified       Atkr       147000     770   1786      75000    105    584
   16
   17   Atkr   Hasty           Atkr         7000      40     52      12000      0     56
   18
   19   Atkr   Hasty           Atkr         9000              8      29954     55     96
   20   Atkr   Prepared        Atkr       132000     765    370     150000    852    320
   21   No     Prepared        Dfdr      1100000    1800   5746    1372200    950   6678
   22   No     Fortified       Atkr      1060300     667   3440     880000    850   2050
   23   No     Prepared        Atkr        54180     539    880      45897    258    370
   24
   25   No     Fortified       Dfdr       124000     515    558     120000    450    576
   26   Atkr   Fortified       Atkr       220476    1037    908     105223    593    592
   27   Atkr   Fortified       Atkr       220476    1037    908     105223    593    592
   28   No     Fortified       Atkr       214336     745    906     101528    470
   29   No     Fortified       Atkr       211000     700    906      97000    310
   30   Dfdr   Hasty           Dfdr          465      13      0        188     25      3
   31   Atkr   Hasty           Dfdr        10300     103     62      22000     75    124
   32   No     Fortified       Atkr        24100      94    100       5000      5     34
   33
   34   No     Hasty           Atkr        12917       0    138       4250    128     56
   35   No     Hasty           Atkr        12917       0    138       4250     38     46
   36   No     Hasty           Dfdr        12447     106     82       8390     78     90
   37   No     Hasty           Dfdr        14730      89    106      11230     30    146
   38   No     Hasty           Dfdr        15000     108    164      12917     30    146
   39   No     Hasty           Dfdr        14733      98    106      12691    106    112
   40   No     Delay           Atkr        14730      97    152       6995     58     80
   41   No     Delay           Atkr        15576     106    106       6702     59     80
   42   No     Prepared        Dfdr        13300     108    164      18912     96    152
   43   No     Prepared        Atkr        14557     158     68       8068     39     45
   44   No     Delay           Atkr        18210     106    104       6435     42     51
   45   No     Prepared        Dfdr        16857      73    160       8000     22     59
   46   No     Prepared        Atkr        21265      51    199       8160     39     45
   47   No     Delay           Atkr        21265     106     89       6435     44     43
   48   No     Prepared        Atkr        18480      95    113       7250     22     59
   49   No     Delay           Dfdr        17034     106    101       5152     55     51
   50   No     Prepared        Atkr        14600     158     68       8138     40     45
   51   No     Prepared        Atkr        16400      73    112       7239     22     49
   52   No     Prepared        Atkr        17500      51    168       8128     39     45
   53   No     Prepared        Dfdr        14000     158     68       8088     39     45
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54	No	Prepared	Atkr	16870	106	92	6321	30	41
55	No	Fortified	Dfdr	19513	45	160	6750	38	41
56	No	Fortified	Dfdr	16600	106	110	6566	54	50
57	No	Fortified	Dfdr	17404	106	110	6566	54	50
58	No	Hasty	Atkr	7942	40	41	5200	0	112
59	No	Fortified	Tie	16350	106	106	7942	43	53
60	No	Fortified	Dfdr	17765	51	130	7588	12	37
61	No	Fortified	Atkr	20744	0	140	3288	12	34
62	No	Fortified	Atkr	5551	0	152	3283	12	34
63	Atkr	Hasty	Atkr	19350	71	180	6750	46	66
64	No	Hasty	Dfdr	15317	92	130	17976	71	242
65	No	Prepared	Atkr	26029	107	222	9834	35	122
66	No	Prepared	Atkr	17746	71	296	15098	92	123
67	No	Prepared	Dfdr	26490	107	221	4515	139	82
68	No	Prepared	Tie	7418	27	58	5000	0	76
69	No	Prepared	Atkr	27518	113	223	17730	100	226
70	No	Fortified	Dfdr	13400	70	155	7077	28	102
71	Atkr	Fortified	Dfdr	41974	201	317	20496	75	210
72	Atkr	Fortified	Atkr	21478	24	167	9761	59	185
73	No	Fortified	Dfdr	15367	45	164	19613	106	187
74	No	Fortified	Atkr	18702	249	160	9250	34	123
75	No	Fortified	Atkr	17970	107	160	8141	21	76
76	No	Fortified	Atkr	16458	124	154	7500	21	73
77	No	Delay	Atkr	18306	249	166	8215	40	128
78	No	Delay	Atkr	23190	225	159	7627	30	58
79	No	Hasty	Atkr	13095	130	132	4563	23	40
80	No	Delay	Atkr	17912	104	126	6650	26	40
81	No	Hasty	Atkr	18030	131	148	6653	26	40
82	No	Fortified	Tie	17345	35	100	12569	0	92
83	No	Fortified	Tie	17343	36	100	11343	19	96
84	Atkr	Fortified	Atkr	22374	424	152	12815	89	107
85	Atkr	Fortified	Atkr	19971	106	201	11928	49	88
86	No	Withdraw	Atkr	17925	110	138	6957	52	88
87	Dfdr	Fortified	Dfdr	20683	462	92	12327	65	64
88	No	Fortified	Tie	19047	102	97	10593	19	106
89	No	Fortified	Dfdr	18000	102	93	13715	71	117
90	No	Fortified	Atkr	15557	55	104	7659	0	64
91	No	Fortified	Dfdr	29711	281	146	15001	100	117
92	No	Fortified	Dfdr	17300	0	94	6108	46	61
93	No	Prepared	Atkr	22641	106	115	13012	30	112
94	No	Fortified	Tie	23604	156	121	19255	35	202
95	No	Hasty	Atkr	26607	126	144	10311	31	110
96	No	Fortified	Atkr	38011	71	200	10855	0	125
97	No	Fortified	Atkr	15721	70	145	5700	0	29
98									
99	No	Fortified	Atkr	18228	107	120	7500	23	84
100	Atkr	Fortified	Dfdr	76213	1369	720	57500	528	292
101	No	Fortified	Atkr	126000	650	792	30700	62	318
102	Atkr	Hasty	Dfdr	25500	120	218	27673	340	192
103	No	Hasty	Tie	15646	317	146	8325	15	76
104	No	Prepared	Atkr	17232	318	146	6000	16	32
105	No	Prepared	Atkr	40619	472	296	15000	38	80
106	No	Delay	Tie	59631	585	520	41500	160	248
107	No	Fortified	Dfdr	60794	472	296	39580	88	248
108	No	Hasty	Dfdr	7500	126	12	4800	122	40
109	No	Fortified	Atkr	32283	312	234	19632	63	116
110	No	Fortified	Dfdr	20493	91	177	20250	66	114

111	No	Fortified	Atkr	99583	764	543	23588	71	99
112	No	Fortified	Atkr	43587	326	239	11185	20	152
113	No	Prepared	Atkr	25881	202	142	7565	16	106
114	No	Fortified	Atkr	92393	524	515	28382	63	169
115	No	Prepared	Atkr	10348	115	158	6519	16	81
116	No	Prepared	Atkr	88941	642	519	32396	66	207
117	No	Hasty	Atkr	7935	106	51	5366	30	64
118	No	Prepared	Atkr	15871	211	36	6299	36	87
119	No	Prepared	Atkr	16232	211	104	6713	43	81
120	No	Prepared	Tie	90078	624	543	30712	75	456
121	No	Prepared	Atkr	19773	237	156	6044	23	150
122	No	Delay	Atkr	89977	624	565	31501	42	193
123	No	Fortified	Tie	15224	211	104	5044	18	99
124	Atkr	Hasty	Atkr	10000	4	68	8634	40	60
125	No	Hasty	Tie	87000	251	94	19996	152	108
126	No	Hasty	Dfdr	36678	359	313	4849	152	18
127									
128	No	Fortified	Atkr	120000	316	1173	30000	20	182
129	No	Fortified	Atkr	62000	320	410	45000	55	1180
130	No	Prepared	Atkr	140000	868	470	75000	155	2115
131	No	Prepared	Atkr	60000	280	375	149000	450	1600
132	No	Prepared	Dfdr	56000	205	323	129000	310	1490
133	No	Hasty	Atkr	78000	650	1380	82500	505	419
134	No	Prepared	Atkr	980600	2293	6220	280000	600	1600
135	No	Fortified	Atkr	70000	291	2088	15000	50	171
136	No	Fortified	Atkr	524724	778	3450	210000	300	1300
137	No	Prepared	Atkr	254950	451	2650	84500	229	828
138	No	Fortified	Atkr	25100	6	201	8250	0	44
139	No	Fortified	Atkr	397600	490	3890	72000	50	1050
140	No	Hasty	Atkr	16100	196	215	8500	15	82
141	No	Prepared	Atkr	1200000	1979	11255	900000	900	4800
142	No	Prepared	Atkr	39000	34	730	3300	0	44
143	No	Prepared	Atkr	38500	55	718	12900	103	103
144	No	Prepared	Atkr	12700	0	205	5100	12	78
145	No	Prepared	Dfdr	17550	34	308	6400	24	156
146	No	Mobile	Dfdr	35170	410		13725	160	
147	No	Prepared	Atkr	1250000	1428	10469	500000	400	5320
148	No	Prepared	Atkr	2200000	4230	17990	560000	1200	3050
149	No	Fortified	Atkr	1220000	2035	15540	780000	700	5740
150	No	Fortified	Both	10800	73	420	3100	12	78
151	No	Fortified	Atkr	12115	190	414	3900	32	84
152	No	Fortified	Atkr	13600	78	233	3710	5	26
153									
154	No	Fortified	Atkr	9000	46	278	4836	14	53
155	No	Fortified	Atkr	33935	144	474	18300	40	59
156	No	Fortified	Atkr	3200	23	330	1600	0	30
157	No	Fortified	Atkr	32000	144	800	2685	40	120
158	No	Delay	Atkr	22888	134	95	1400	0	
159	No	Fortified	Atkr	18398	134	173	2900	0	32
160	No	Fortified	Atkr	18111	151	221	4731	0	32
161	No	Fortified	Atkr	16291	125	221	2600	0	38
162	No	Fortified	Dfdr	14594	126	203	5000	0	40
163	No	Fortified	Dfdr	15986	123	226	4500	0	40
164	No	Fortified	Dfdr	15764	126	329	4050	0	40
165	No	Hasty	Dfdr	6850	0	60	15350	140	198
166	No	Fortified	Atkr	15109	140	209	5140	0	30
167	Atkr	Prepared	Atkr	16043	0	50	3338	0	2

168	Atkr	Hasty	Dfdr	4000	0	8	15777	0	157
169	No	Fortified	Dfdr	15640	0	171	3000	0	24
170	No	Fortified	Atkr	15205	79	150	2600	0	3
171	No	Fortified	Tie	16091	122	129	3500	0	12
172	No	Fortified	Atkr	16002	122	180	2500	0	12
173	No	Fortified	Atkr	8237	40	53	2500	0	6
174	No	Fortified	Atkr	15808	109	141	2000	0	6
175	No	Delay	Atkr	19082	138	95	2000	0	0
176	No	Fortified	Atkr	18388	74	174	2900	0	32
177	No	Fortified	Dfdr	21247	0	246	3000	0	32
178	No	Fortified	Atkr	17163	100	228	3000	0	34
179	No	Fortified	Atkr	18095	97	200	3900	0	36
180	No	Fortified	Tie	19714	121	157	5284	0	34
181	No	Fortified	Tie	20973	129	210	4757	0	34
182	No	Fortified	Atkr	19658	140	183	4217	0	34
183	No	Prepared	Atkr	18777	113	177	4000	0	21
184	No	Prepared	Tie	18660	117	172	4250	0	11
185	No	Prepared	Atkr	19047	115	206	3250	0	5
186									
187	No	Prepared	Atkr	30000		100	17000		78
188									
189	No	Hasty	Dfdr	11000	0	72	15200	215	72
190	No	Delay	Atkr	16600	200	70	10300	0	72
191	No	Delay	Atkr	16400	200	70	9000	0	28
192	No	Delay	Atkr	16200	215	72	7100	0	23
193	No	Prepared	Atkr	25500	215	162	27000	0	748
194	No	Hasty	Atkr	29000	215	72	30200	0	648
195	No	Hasty	Atkr	26000	215	72	12500	0	288
196	No	Delay		30700	0	240	26900	215	72
197	No	Hasty	Atkr	27900	215	72	35100	0	203
198	No	Hasty	Dfdr	37000	0	192	13800	118	85
199	No	Prepared	Atkr	13700	118	72	35500	0	72
200									
201	No	Prepared	Tie	3000	15	2	3600	8	4
202	No	Prepared		4500	57	14	2500	40	8
203	No	Prepared	Atkr	4000	100	2	2500	0	16
204	No	Hasty	Dfdr	3000	60	6	2700	25	16
205	No	Prepared		6000	60	32	6000	60	24
206	No	Prepared	Atkr	2500	0	2	3000	0	8
207	No	Prepared	Atkr	2500	25	8	3000	40	24
208	No	Prepared	Atkr	6000	75	24	4000	90	16
209	No	Prepared	Atkr	4000	50	16	3000	67	12
210									
211	No	Fortified	Dfdr	4700	72	27	4000	38	32
212	No	Fortified	Atkr	2608	40	5	3300	68	24
213	No	Fortified	Atkr	10000	106	32	10050	108	130
214	No	Prepared	Atkr	4000	25	12	6400	8	44
215									
216	Atkr	Prepared	Atkr	10900	100	36	6160	40	20
217	Atkr	Fortified	Atkr	27682	91	72	13600	40	36
218	No	Hasty	Atkr	12800	140	48	9900	120	24
219	No	Hasty	Atkr	5350	90	24	5450	60	24
220	No	Hasty	Atkr	10700	180	48	8640	84	24
221									
222	No	Prepared	Tie	11940	128	67	16168	60	91
223									
224	Atkr	Prepared	Atkr	19520	240	84	19520	197	68

225	No	Hasty	Atkr	10450	180	48	10050	180	48
226	Atkr	Fortified	Atkr	19280	120	72	18450	114	126
227	No	Prepared	Atkr	6350	90	48	12750	78	36
228	No	Prepared	Tie	10800	184	48	3000	60	48
229	No	Prepared	Atkr	12150	100	72	17450	134	114
230	No	Prepared	Atkr	8700	146	48	3000	40	24
231	No	Hasty	Dfdr	22000	224	114	7250	90	48
232	No	Delay	Atkr	10200	220	72	13500	172	48
233	Atkr	Hasty	Atkr	18780	120	72	18450	114	72
234	No	Hasty	Dfdr	3500	60		3600	70	0
235									
236	No	Fortified	Atkr	5375	10	24	8160	75	70
237	No	Fortified	Atkr	5350	90	24	4350	50	76
238	No	Fortified	Atkr	5850	90	24	8560	75	82
239	No	Prepared	Atkr	11400	184	48	9080	175	72
240	No	Prepared	Atkr	16500	409	72	19300	505	132
241	No	Prepared	Atkr	17550	224	72	16767	366	108
242									
243	Atkr	Prepared	Atkr	29490	67	1223	4455	67	40
244	No	Hasty	Atkr	63910	464	639	14000	192	40
245	Atkr	Prepared	Atkr	22850	71	971	3020	52	28
246	No	Hasty	Atkr	45160	310	555	10980	148	24
247	No	Hasty	Dfdr	25850	530	44	67440	516	639
248	No	Hasty	Dfdr	81160	1002	585	43400	714	144
249	No	Hasty	Dfdr	57960	709	447	28600	348	96
250	Atkr	Hasty	Atkr	22790	344	96	30970	389	322
251	No	Hasty	Atkr	28900	444	72	36840	419	347
252	No	Hasty	Atkr	19600	232	72	18180	293	119
253	No	Hasty	Dfdr	17000	232	72	23860	246	72
254	No	Hasty	Atkr	16200	318	48	35623	454	150
255	No	Hasty	Atkr	16200	318	72	25600	445	160
256	No	Withdraw	Atkr	11700	126	48	22570	259	139
257	No	Hasty	Dfdr	14681	225	60	22570	259	139
258	No	Fortified	Atkr	10900	164	36	14620	199	37
259									
260	Atkr	Prepared	Tie	17750	75	115	3630	50	12
261	Atkr	Fortified	Dfdr	22750	147	131	5745	78	16
262	Atkr	Fortified	Atkr	19525	147	129	4958	75	24
263	Atkr	Hasty	Dfdr	21984	189	129	6300	106	136
264	Atkr	Hasty	Dfdr	12500	318	71	6946	110	36
265	No	Hasty	Atkr	17833	249	60	23750	253	150
266	No	Hasty	Atkr	12733	219	60	14683	170	90
267	No	Prepared	Dfdr	31650	182	155	5395	38	24
268	No	Fortified	Dfdr	2692	9	12	1583	5	24
269	No	Fortified	Atkr	16100	270	60	19400	329	110
270	No	Prepared	Atkr	14700	318	60	21500	387	130
271	Dfdr	Hasty	Dfdr	12500	318	71	14300	318	60
272	Atkr	Hasty	Atkr	11000	212	40	12000	269	70
273	No	Prepared	Dfdr	11500	269	48	11000	212	48
274	No	Prepared	Dfdr	35750	566	198	16100	270	60
275	No	Fortified	Dfdr	5700	0	12	4750	0	27
276	No	Fortified	Atkr	11400	0	24	4750	0	27
277									
278	No	Prepared	Atkr	34500	775		25000	362	
279									

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